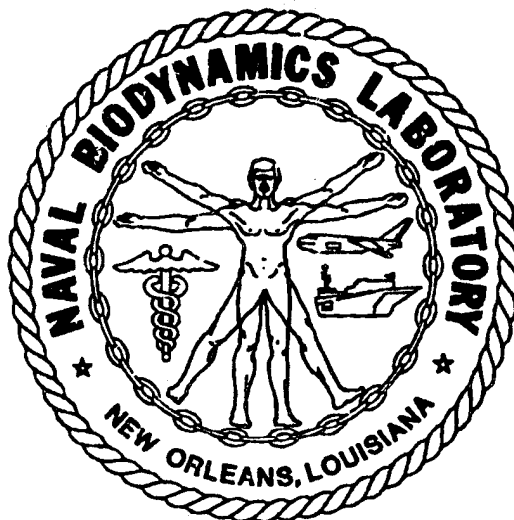


**ANTHROPOMETRY AND MASS DISTRIBUTION  
FOR HUMAN ANALOGUES**

**VOLUME I: MILITARY MALE AVIATORS**

March 1988

Naval Biodynamics Laboratory  
P.O. Box 29407  
New Orleans, LA 70189-0407



19960215 068

Approved for public release; distribution is unlimited.

Prepared for

Naval Medical Research and Development Command  
Bethesda, MD 20889-5044

DTIC QUALITY INSPECTED 1

81K003

# **Anthropometry and Mass Distribution for Human Analogues**

## **Volume I: Military Male Aviators**

**March 1988**



**Harry G. Armstrong Aerospace Medical Research Laboratory  
Wright-Patterson Air Force Base, Ohio 45433-6573  
AAMRL-TR-88-010**

**Naval Aerospace Medical Research Laboratory  
Pensacola, Florida 32508-5700  
NAMRL-1334**



**Naval Air Development Center  
Warminster, Pennsylvania 18940-5000  
NADC-88036-60**

**Naval Biodynamics Laboratory  
New Orleans, Louisiana 70189-0407  
NBDL 87R003**



**U.S. Air Force School of Aerospace Medicine  
Brooks Air Force Base, Texas 78235-5301  
USAFSAM-TR-88-6**

**U.S. Army Aeromedical Research Laboratory  
Fort Rucker, Alabama 36362-5292  
USAARL Report No. 88-5**



## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AAMRL-TR-88-010; NAMRL-1334; NADC-88036-60; NBDL 87R003; USAFSAM-TR-88-6; and USAARL 88-5			7a. NAME OF MONITORING ORGANIZATION Tri-Service Committee of the Tri-Service Aeromedical Research Panel		
6a. NAME OF PERFORMING ORGANIZATION Anthropology Research Project		6b. OFFICE SYMBOL (If applicable)	7b. ADDRESS (City, State, and ZIP Code) P.O. Box 577 Fort Rucker, AL 36362-5292		
6c. ADDRESS (City, State, and ZIP Code) Yellow Springs, Ohio		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army, Air Force, and Navy		8b. OFFICE SYMBOL (If applicable)	10. SOURCE OF FUNDING NUMBERS		
8c. ADDRESS (City, State, and ZIP Code)		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) Anthropometry and mass distribution for human analogues, volume I: Military aviators (U)					
12. PERSONAL AUTHOR(S)					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) 1988 March	
15. PAGE COUNT 74					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Anthropometry, anthropology, human mass distribution, human limb pivot axes, pilot size		
05	09				
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>Anthropometric and mass distribution data for use in constructing three-dimensional human analogues -- mathematical models or test dummies -- are presented in this report. Included here are body dimensions, joint locations, and mass distribution properties appropriate for modeling the Small, Mid-size, and Large male aviator of the 1980s. The data were derived from: (1) 139 body dimensions of standing and seated males obtained by traditional anthropometric methods; (2) mass distribution data for body segments obtained by stereophotographic techniques; and (3) skeletal joint centers obtained by estimation. The anthropometric data, generated from multiple regressions on stature and weight, are suitable as the basis for models to be used in testing responses to impact and other mechanical forces; they are not recommended for other purposes such as the sizing of clothing and personal protective equipment, or workspace design.</p>					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL Chief, Scientific Information Center			22b. TELEPHONE (Include Area Code) (205) 255-6907		22c. OFFICE SYMBOL SGRD-HAY-ST

## PREFACE

This publication is the culmination of a project initiated more than seven years ago by Mr. Joe Haley of the U.S. Army Aeromedical Research Laboratory (USAARL). A great many people, including representatives from industry, academic institutions, and a number of government agencies, cooperated in the development of this tri-service data base for use in the construction of three-dimensional human analogues. The lengthy process of generating and selecting data appropriate and acceptable to the Air Force, Army, and Navy was begun on 13 March 1980 at the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL). Final coordination and agreement was achieved through the Tri-Service Working Group on Biomechanics, which facilitated the achievement of specifications acceptable to all three services, and provided for final report preparation.

Special acknowledgement is made to Mr. Richard Chandler and Mr. Joe Young of the Civil Aeromedical Institute of the Federal Aviation Administration for their recommendations, to Dr. Ints Kaleps of the AAMRL for coordinating and incorporating comments and recommendations, and to the staff of Anthropology Research Project, Inc. for conducting numerous analyses and preparing the final report. Illustrations were designed and executed by Gary Ball.

## TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION .....	5
ANTHROPOMETRY .....	6
Data Base .....	6
Body Size .....	6
Body Segmentation .....	32
Mass Distribution .....	34
Segmental Masses .....	34
Body Linkage and Center of Mass (CM) Locations ..	40
DEFINITIONS .....	47
BIBLIOGRAPHY .....	52

# LIST OF ILLUSTRATIONS

<u>Figure</u>		<u>Page</u>
1	The body in standard anatomical position .....	7
2	Planes of body segmentation .....	33
3	Principal axis orientation for the head relative to the anatomical axis sytem.....	39
4	Body linkage and centers of mass (excludes arms) for the Small male aviator.....	41
5	Centers of mass and linkage for the arms of the Small male aviator.....	42
6	Body linkage and centers of mass (excludes arms) for the Mid-size male aviator.....	43
7	Centers of mass and linkage for the arms of the Mid-size male aviator.....	44
8	Body linkage and centers of mass (excludes arms) for the Large male aviator.....	45
9	Centers of mass and linkage for the arms of the Large male aviator.....	46

## LIST OF TABLES

### Table

1	Dimensions of the Small, Mid-Size and Large Male Aviator .....	8
2	Mass Distribution of the Body Segments .....	35

## INTRODUCTION

The comparative testing, analysis and evaluation of the safety and performance of manned systems require the use of standardized mechanical or analytical human surrogates which approximate human body properties. This document provides the design parameters for the Small, the Mid, and the Large sized male aviator, with mass distribution and body size appropriate for the 1980-1990 time period. Included in this document are data for body dimensions, joint locations, and mass distribution properties.

The data provided in this document are meant to serve as a basis for three-dimensional mathematical models and test dummies which are to be used for investigating responses to impact or other mechanical forces. The dimensions in this report have been generated from multiple regressions on stature and overall body weight. This method provides internally consistent body dimensions for each model but does not necessarily provide appropriate descriptive statistics for a population for any single dimension. For example, when compared to the 1967 survey of U.S. Air Force rated male aircrew (Churchill, Kikta and Churchill, 1977), the Small and Large values for head breadth in this document rank at 38th and 69th percentiles, respectively. Only 31% of the Air Force survey personnel fall within these bounds. Therefore, it is strongly recommended that the data in this document not be used for purposes such as fit analysis, sizing of personal protective equipment and clothing, or for workspace design or evaluation.



## ANTHROPOMETRY

### Data Base

The criteria in this document are derived from: (1) body dimensions obtained by traditional anthropometric methods; (2) mass distribution data obtained by stereophotographic techniques; and (3) skeletal joint centers obtained by estimation. All computations for the Small, Mid-size, and Large male aviator are based on stature and weight.

### Body Size

A total of 139 body dimensions of standing and seated males are reported here. Most of these anthropometric measurements were derived from stature and weight multiple regression equations calculated from the 1967 survey of U.S. Air Force rated male aircrew. The stature and weight values used were the 3rd, 50th, and 95th percentiles projected to reflect assumed increases in body size between 1967 and the 1980-1990 time period (Churchill and McConville, 1976). Those dimensions not measured in the 1967 survey were derived from those data or were estimated from other studies (McConville and Laubach, 1978; McConville et al., 1980) and are marked with an asterisk. Body dimensions are referenced to the standard "anatomical position," with the head in the Frankfort plane, unless otherwise specified in the measurement description. This position and body reference terminology is illustrated in Figure 1. For design purposes, the body is assumed to be bilaterally symmetrical. Dimension descriptions and measurement data are given in Table 1.

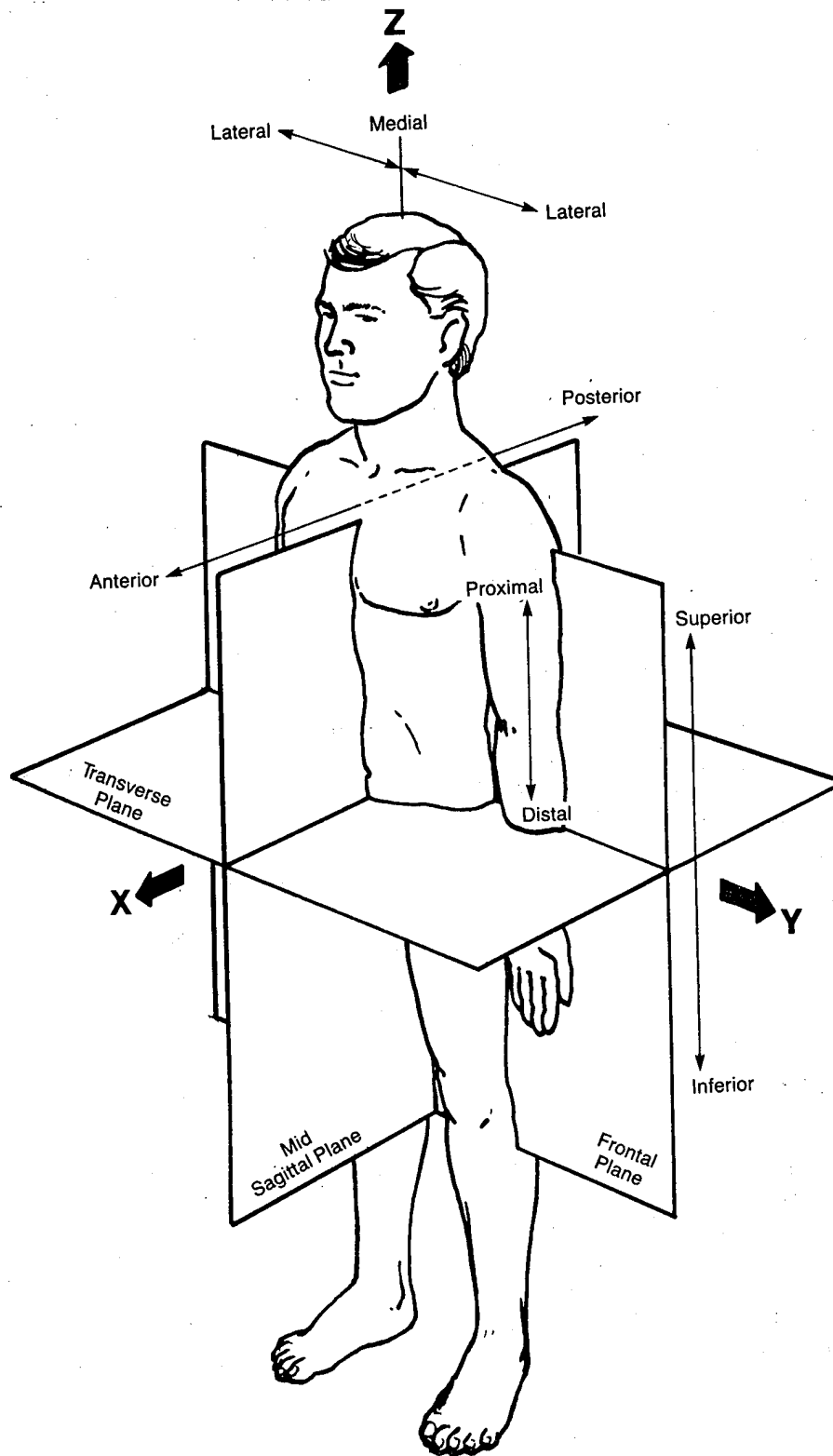


Figure 1. The body in standard anatomical position.

TABLE 1

## DIMENSIONS OF THE SMALL, MID-SIZE AND LARGE MALE AVIATOR

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
*1 ABDOMINAL DEPTH, SITTING: The maximum horizontal depth of the abdomen.	22.4	25.5	28.1
2 ACROMIAL HEIGHT: The vertical distance between the standing surface and the lateral tip of the shoulder (acromion).	136.6	146.2	155.7
3 ACROMIAL HEIGHT, SITTING: The vertical distance between the sitting surface and the lateral tip of the shoulder (acromion).	57.8	61.5	65.0
4 ACROMION-RADIALE LENGTH: The length of the upper arm measured as the vertical distance between the lateral tip of the shoulder (acromion) and the proximal end of the radius (radiale).	31.1	33.2	35.2
5 ANKLE CIRCUMFERENCE: The minimum horizontal circumference of the lower leg (calf).	21.1	22.7	24.1
6 ANKLE HEIGHT: The vertical distance between the standing surface and the level of the ankle circumference.	13.0	13.8	14.6
7 ANTERIOR NECK LENGTH: The surface distance in the midsagittal plane between the point of the deepest depression of the top of the breastbone (suprasternale) and the juncture of the neck and the jaw.	8.3	8.4	8.5
*8 AXILLA HEIGHT: The vertical distance between the standing surface and the apex of the armpit (axilla).	126.6	135.1	143.6
9 BALL OF FOOT CIRCUMFERENCE: The circumference of the foot passing over the maximum protuberance of the first metatarsal bone and the fifth metatarsal bone.	23.6	25.0	26.4
10 BIACROMIAL BREADTH: The horizontal distance between the lateral tips of the shoulders (right and left acromion).	39.1	41.0	42.8
11 BIAURICULAR BREADTH: The horizontal distance between the most lateral points of the right and left ears.	18.4	18.9	19.3
12 BICEPS CIRCUMFERENCE: The circumference of the upper arm perpendicular to its long axis, measured with the arm hanging relaxed at the side. (The level of the dimension is established at the maximum protrusion of the flexed biceps.)	28.4	31.3	33.7
13 BICRISTAL BREADTH (Bone): The maximum horizontal distance between the lateral crests of the pelvis (ilia) measured with enough pressure to compress the tissue.	25.8	28.3	30.5

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

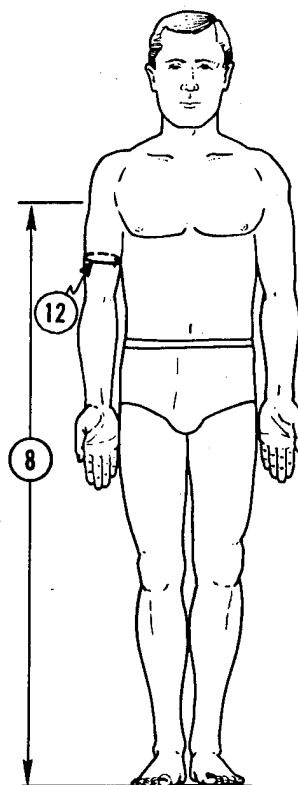
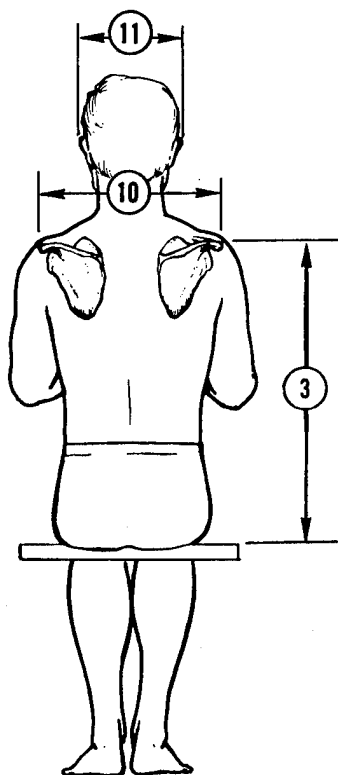
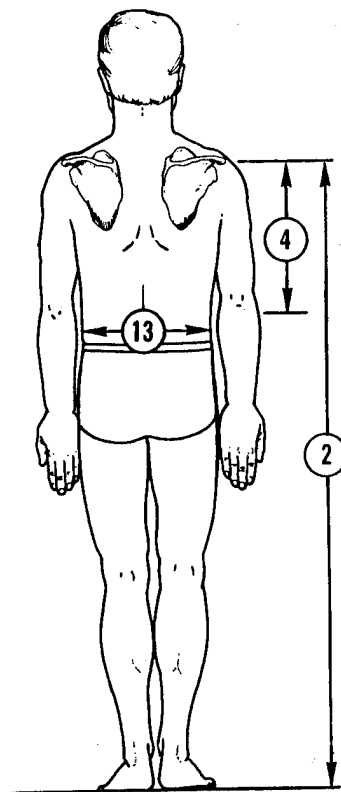
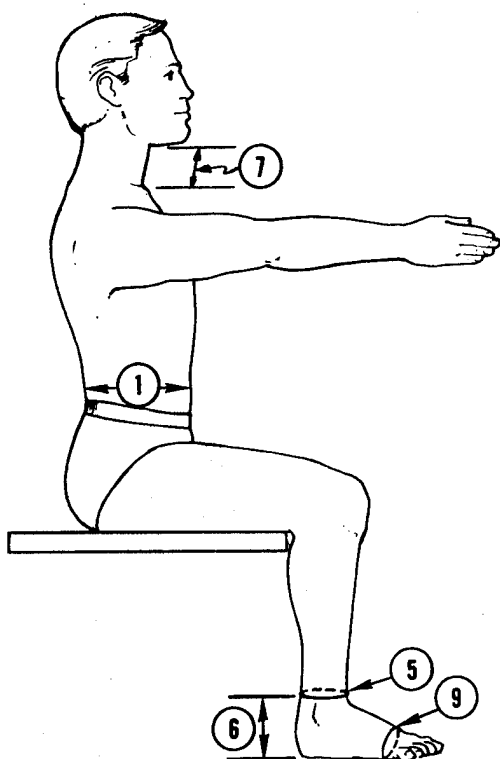


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
14 BIDELOID BREADTH: The maximum horizontal distance across the shoulders at the level of the deltoid muscles.	45.3	48.8	51.9
15 BIGONIAL BREADTH: The horizontal distance between the corners of the jaw (right and left gonion).	11.4	11.8	12.2
16 BIMALLEOLAR BREADTH: The maximum horizontal distance between the lateral and the medial protrusions of the ankle (medial and lateral malleolus).	7.0	7.4	7.8
17 BIOULAR BREADTH: The horizontal distance between the outer corners of the eyes (right and left ectocanthus).	9.0	9.2	9.4
18 BITRAGON BREADTH: The horizontal distance between the right and the left tragon (the point at the top of the cartilaginous flap in front of the opening of the ear).	13.9	14.3	14.7
19 BITRAGON-CORONAL ARC: The vertical surface distance between the right and the left tragon passing over the top of the head.	35.0	35.9	36.7
20 BITRAGON-MENTON ARC: The surface distance between the right and the left tragon passing over the tip of the chin (menton).	31.5	32.8	34.0
21 BITRAGON-MINIMUM FRONTAL ARC: The surface distance between the right and the left tragon passing over the greatest indentation of each temporal crest (frontotemporale).	30.2	30.9	31.6
22 BITRAGON-POSTERIOR ARC: The surface distance between the right and the left tragon passing over a bony midline point on the back of the head (inion).	28.7	29.6	30.4
23 BITRAGON-SUBMANDIBULAR ARC: The surface distance between the right and the left tragon passing over the juncture of the jaw with the neck.	29.6	31.2	32.6
24 BITRAGON-SUBNASALE ARC: The surface distance between the right and the left tragon, passing over the juncture of the nose with the philtrum.	28.6	29.4	30.2
25 BIZYGOMATIC BREADTH (Face Breadth): The horizontal distance between the maximum protrusions of the cheekbones (zygomatic arches).	13.9	14.3	14.7
26 BUTTOCK CIRCUMFERENCE: The horizontal circumference of the body at the level of the maximum protrusion of the buttocks.	91.1	100.0	107.8

TABLE 1 (cont'd)

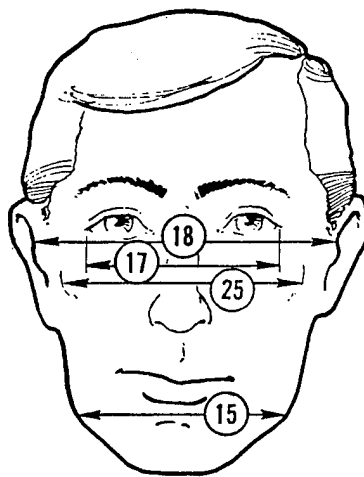
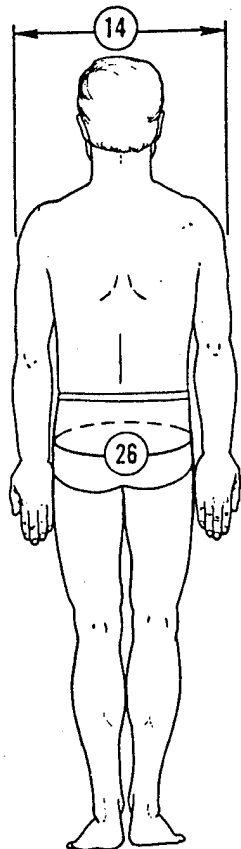
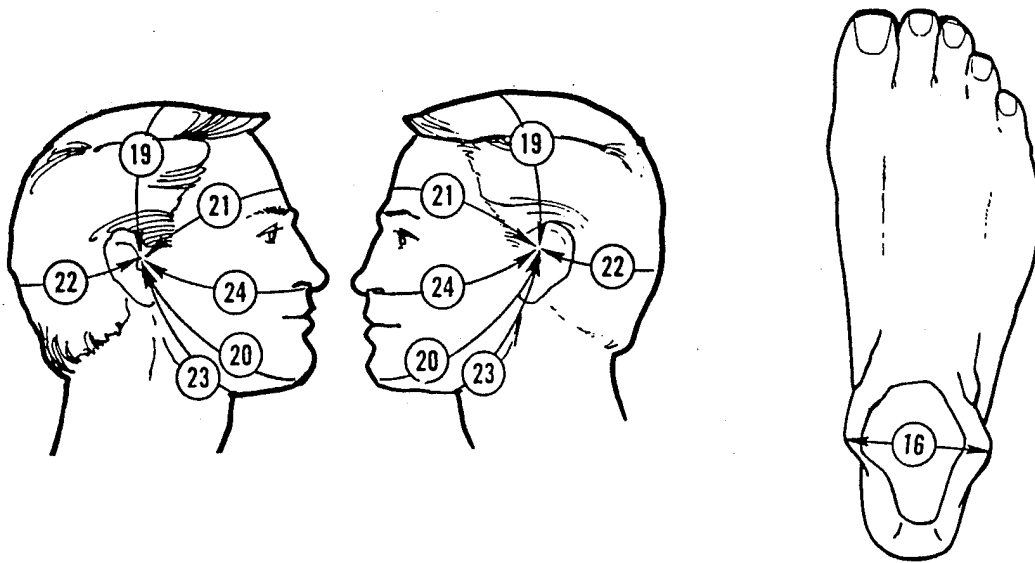


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
27 BUTTOCK DEPTH: The horizontal depth of the body at the level of the maximum protrusion of the buttocks.	21.7	24.4	26.8
28 BUTTOCK HEIGHT: The vertical distance between the standing surface and the level of the maximum protrusion of a buttock.	84.4	90.8	97.0
29 BUTTOCK-KNEE LENGTH: The horizontal distance between the maximum protrusion of a buttock and the anterior point of the knee of a seated subject. The knee is flexed 90 degrees.	56.6	60.9	65.0
30 BUTTOCK-POPLITEAL LENGTH: The horizontal distance between the maximum protrusion of a buttock and the posterior surface of the knee of a seated subject. The knee is flexed 90 degrees.	47.1	50.8	54.4
31 CALF CIRCUMFERENCE: The maximum horizontal circumference of the calf.	34.7	37.7	40.3
32 CALF HEIGHT: The vertical distance between the standing surface and the level of the maximum circumference of the calf.	33.0	35.8	38.6
33 CERVICALE HEIGHT: The vertical distance between the standing surface and the tip of the spinous process of the 7th cervical vertebra (cervicale).	143.4	153.1	162.6
*34 CERVICALE HEIGHT, SITTING: The vertical distance between the sitting surface and cervicale.	64.6	68.4	72.0
35 CHEST BREADTH: The horizontal breadth of the chest at the level of the nipples.	30.5	33.2	35.6
36 CHEST CIRCUMFERENCE: The horizontal circumference of the chest at the level of the nipples.	91.2	100.0	107.5
37 CHEST CIRCUMFERENCE AT SCYE: The circumference of the chest at the level of an axillary fold (scye point).	95.3	103.6	110.8
38 CHEST DEPTH: The horizontal depth of the chest at the level of the nipples.	22.5	24.9	27.0
39 CHEST HEIGHT: The vertical distance between the standing surface and the level of the nipple.	121.9	130.1	138.2
*40 CHEST HEIGHT, SITTING: The vertical distance between the sitting surface and the level of the nipple.	43.1	45.4	47.6
41 CROTCH HEIGHT: The vertical distance between the standing surface and the midpoint of the crotch.	80.2	85.6	91.1

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

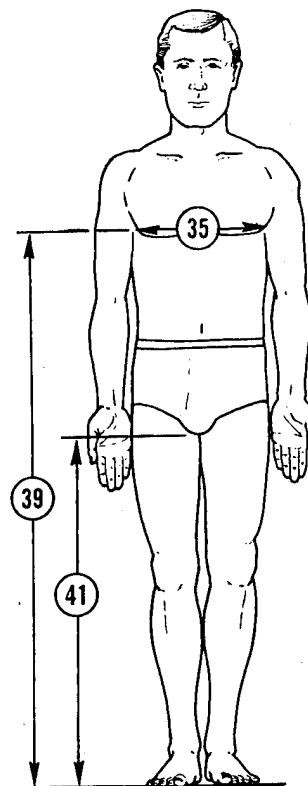
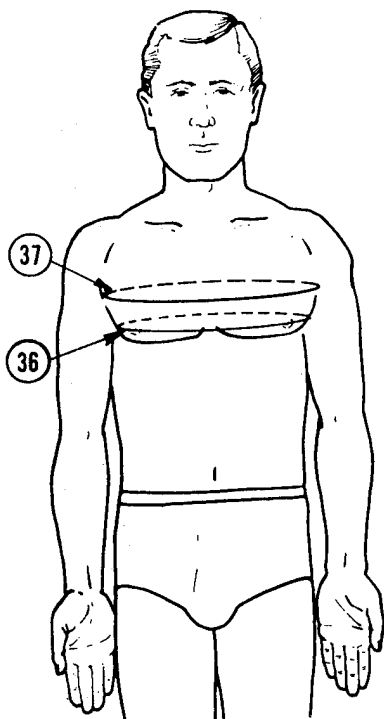
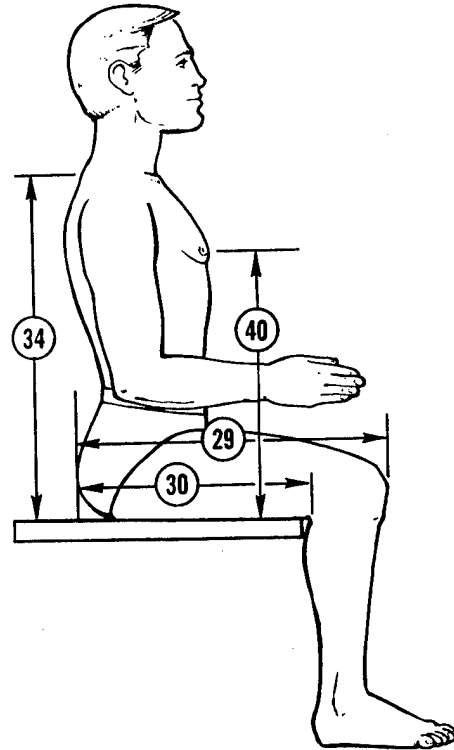
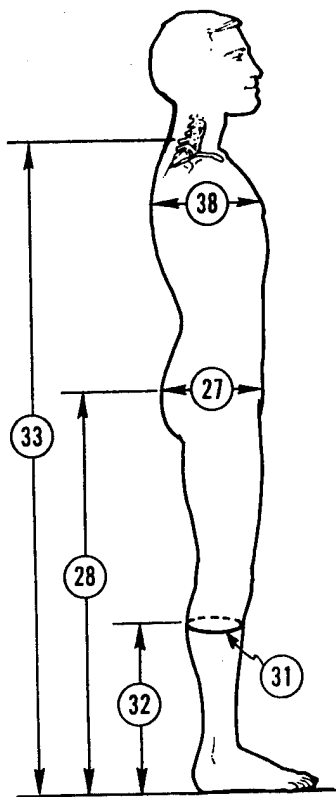




TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
42 EAR BREADTH: The breadth of the ear perpendicular to its long axis.	3.7	3.8	3.9
43 EAR LENGTH: The length of the ear along its long axis.	6.4	6.6	6.9
44 EAR LENGTH ABOVE TRAGION: The distance along the long axis from tragon to the top of the ear.	2.9	2.9	3.0
45 EAR PROTRUSION: The horizontal distance between the most protruding point on the surface of the ear and the bony eminence of the mastoid process immediately behind the ear.	2.1	2.2	2.3
46 ECTOCANTHUS TO TOP OF HEAD: The vertical distance between the outer corner of an eye (ectocanthus) and the plane of the top of the head.	11.7	12.0	12.2
47 ECTOCANTHUS TO WALL: The horizontal distance between the outer corner of an eye (ectocanthus) and the plane of the back of the head	17.5	17.8	18.1
48 ELBOW CIRCUMFERENCE: The circumference of the elbow perpendicular to the long axis of the arm passing over the tip of the elbow (olecranon process).	26.0	28.0	29.8
49 ELBOW HEIGHT: The vertical distance between the standing surface and the proximal end of the radius (radiale).	105.6	113.1	120.5

TABLE 1 (cont'd)

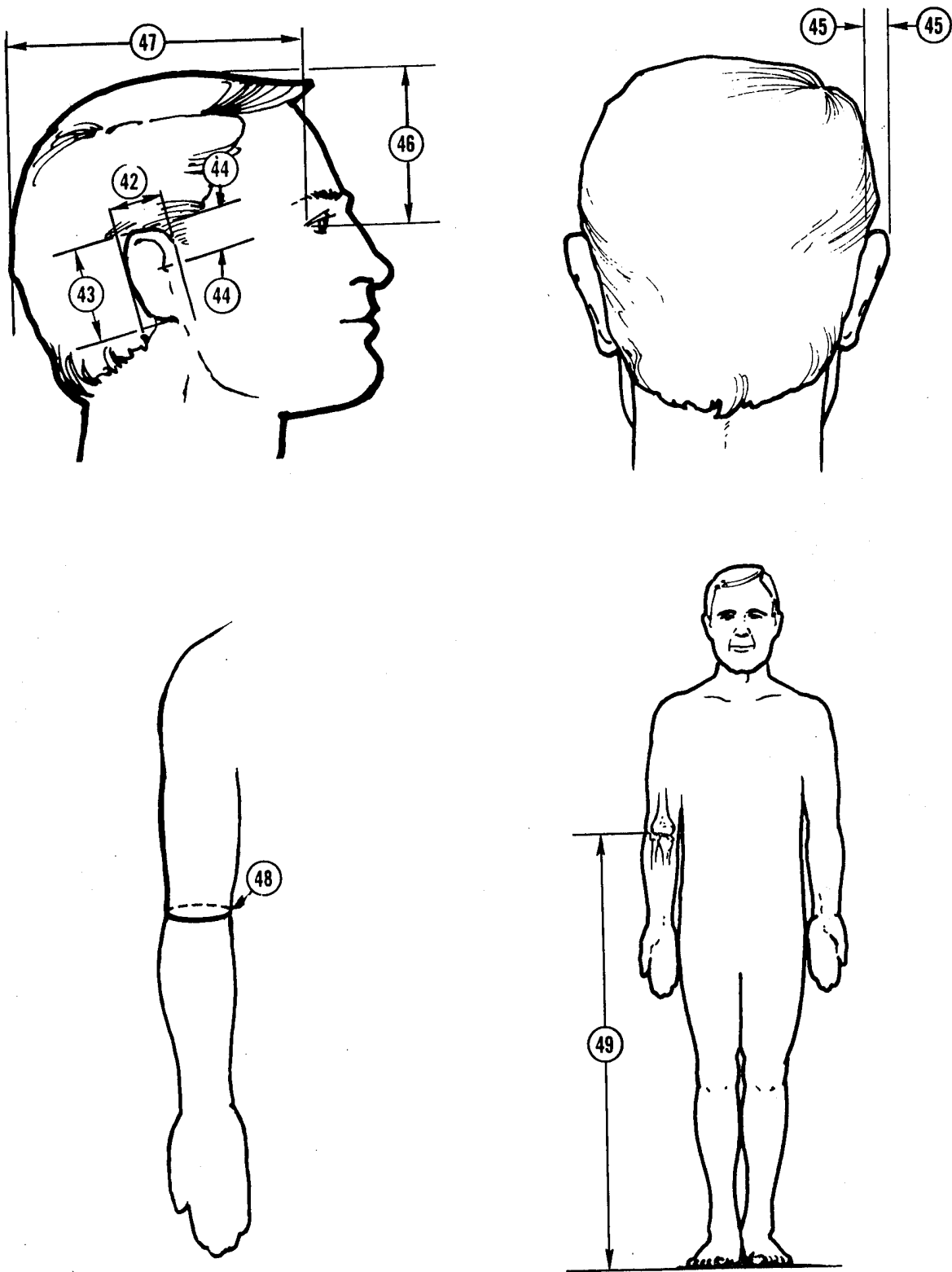


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
50 ELBOW REST HEIGHT: The vertical distance between the sitting surface and the bottom of the elbow with the upper arm hanging freely and the forearm flexed 90 degrees.	23.9	25.4	26.7
51 ELBOW-WRIST LENGTH: The distance between the tip of the elbow (olecranon process) and the distal end of the radius (stylium) with the upper arm hanging freely and the elbow flexed 90 degrees.	28.4	30.2	32.0
52 EYE HEIGHT, SITTING: The vertical distance between the sitting surface and the outer corner of an eye (ectocanthus).	77.5	81.4	85.1
53 FEMORAL BREADTH (Bone): The breadth of the femur between its medial and lateral epicondyles with the tissue compressed.	9.5	10.1	10.6
54 FOOT BREADTH: The maximum breadth of the foot perpendicular to its long axis.	9.3	9.8	10.3
55 FOOT LENGTH: The maximum length of the foot parallel to its long axis.	25.7	27.2	28.7
56 FOREARM CIRCUMFERENCE: The maximum circumference of the forearm perpendicular to its long axis.	26.5	28.5	30.2
*57 FOREARM-HAND LENGTH: The distance between the tip of the elbow (olecranon process) and the tip of the middle finger (dactylion) when the upper arm is hanging freely and the elbow is flexed 90 degrees.	46.6	49.3	52.0
58 GLABELLA TO TOP OF HEAD: The vertical distance from the midsagittal point between the browridges (glabella) to the plane of the top of the head.	9.2	9.3	9.4

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

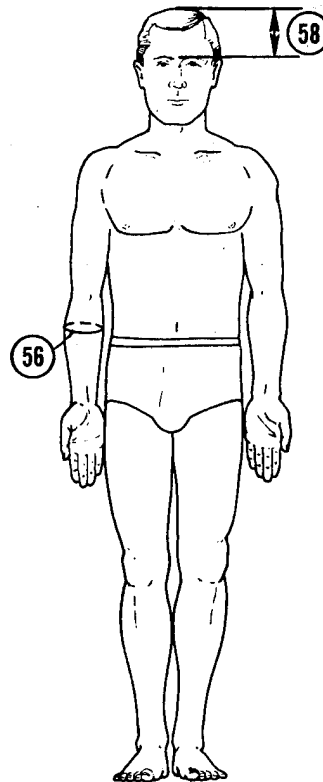
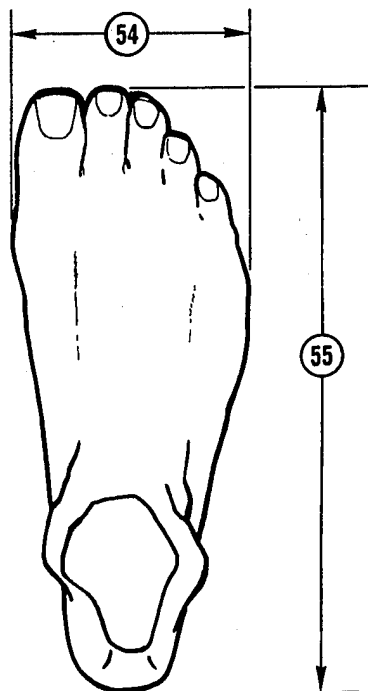
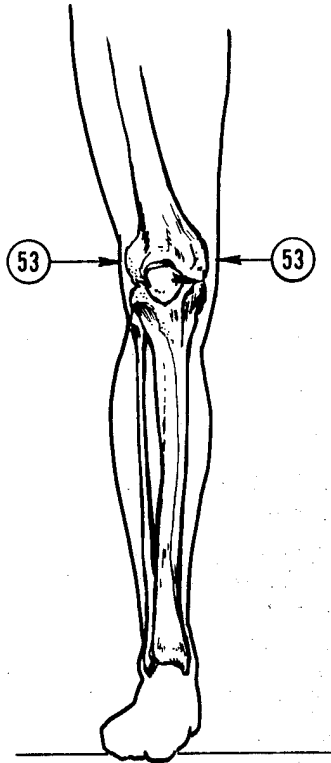
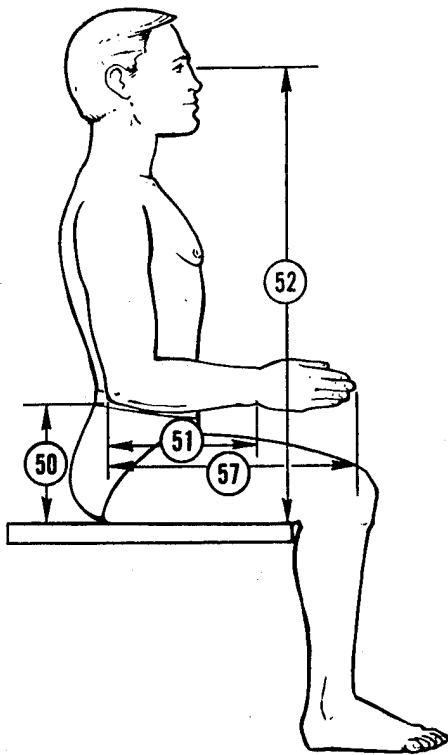


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
59 GLABELLA TO WALL: The horizontal distance from the midsagittal point between the browridges (glabella) to the plane of the back of the head.	20.0	20.4	20.8
60 GLUTEAL FURROW HEIGHT: The vertical distance between the standing surface and the lowest point of the juncture of the curve of a buttock with the thigh (gluteal furrow).	76.1	81.7	87.3
61 HAND BREADTH: The breadth of the hand between the second and the fifth metacarpal-phalangeal joints.	8.5	9.0	9.4
62 HAND BREADTH ACROSS THUMB: The breadth of the hand, perpendicular to its long axis, at the level of the metacarpal-phalangeal joint of the thumb.	9.7	10.3	10.8
63 HAND CIRCUMFERENCE: The circumference of the hand around the second and fifth metacarpal-phalangeal joints.	20.7	21.7	22.6
64 HAND CIRCUMFERENCE INCLUDING THUMB: The circumference of the hand, perpendicular to its long axis, passing over the first metacarpal-phalangeal joint.	24.6	25.9	27.2
65 HAND LENGTH: The distance between the end of the forearm (stylium) and the tip of the middle finger (dactylion) parallel to the long axis of the hand.	18.3	19.2	20.1
66 HAND THICKNESS: The thickness of the hand between the palm and the top of the third knuckle of the hand (head of the third metacarpal).	2.7	2.8	2.9

TABLE 1 (cont'd)

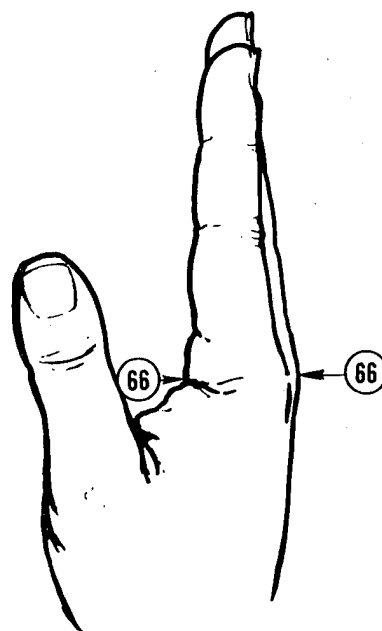
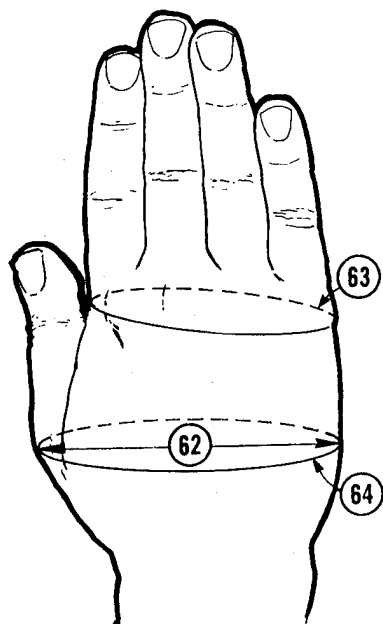
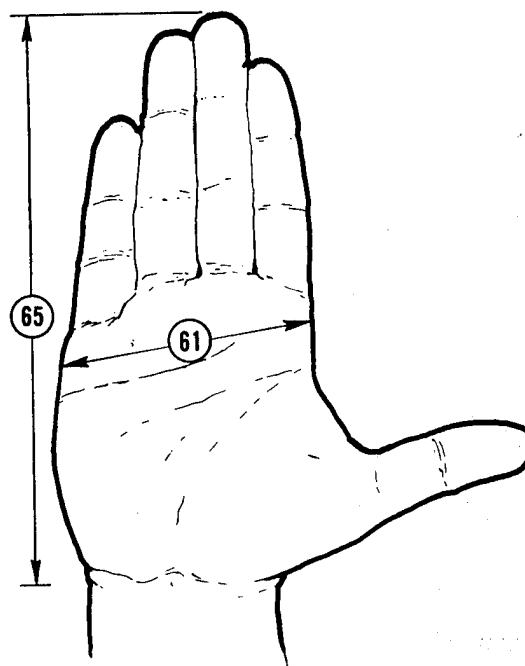
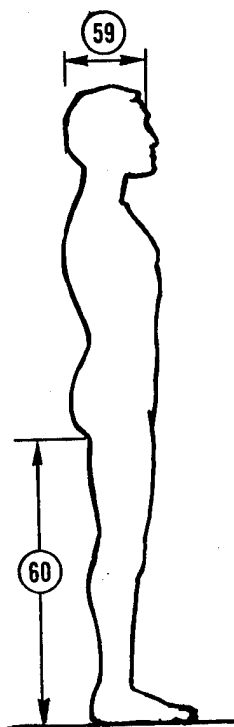


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	SMALL	MID	LARGE
67 HEAD BREADTH: The maximum horizontal breadth of the head above the ears.	15.4	15.6	15.9
68 HEAD CIRCUMFERENCE: The maximum circumference of the head above the browridges and ears.	56.5	57.7	58.8
69 HEAD DIAGONAL FROM INION TO PRONASALE: The distance between the tip of the nose (pronasale) and the point inion on the back of the head.	21.5	22.0	22.5
70 HEAD DIAGONAL-MAXIMUM FROM MENTON TO OCCIPUT: The maximum distance between the tip of the chin (menton) and the back of the head (occiput).	25.0	25.7	26.3
71 HEAD LENGTH: The maximum distance from the mid-sagittal point between the browridges (glabella) to the back of the head	19.5	19.9	20.3
72 HEEL-ANKLE CIRCUMFERENCE: The circumference of the foot and ankle passing under the tip of the heel and over the anterior juncture of the foot with the ankle.	32.1	34.2	36.2
73 HIP BREADTH: The maximum horizontal breadth of the hips.	32.9	35.7	38.2
74 HIP BREADTH, SITTING: The maximum horizontal breadth of the hips of a seated subject.	34.8	38.3	41.5
75 HUMERAL BREADTH (Bone): The breadth of the humerus between its medial and lateral epicondyles with the tissue compressed.	6.8	7.1	7.5
*76 ILIOCRISTALE HEIGHT: The vertical distance from the standing surface to the top of the pelvis (ilium) in the midaxillary line.	100.0	107.3	114.5
77 INSTEP CIRCUMFERENCE: The vertical circumference of the arch of the foot.	24.3	25.9	27.4
78 INSTEP LENGTH: The horizontal distance between the back of the heel and the level of the maximum medial protrusion of the foot.	18.8	19.9	21.0
79 INTEROCULAR BREADTH: The horizontal distance between the inner corner of each eye (endocanthus).	3.3	3.3	3.4
80 INTERPUPILLARY BREADTH: The horizontal distance between the center of the pupil of each eye.	6.2	6.3	6.4
81 INTERSCYE: The horizontal surface distance across the back between the lowest points of the posterior axillary folds.	36.7	39.2	41.3

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

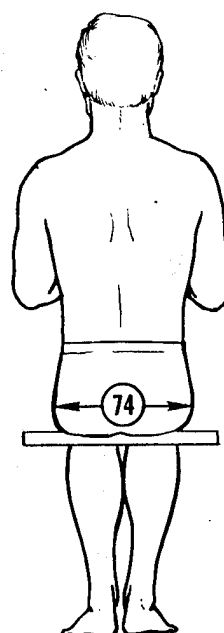
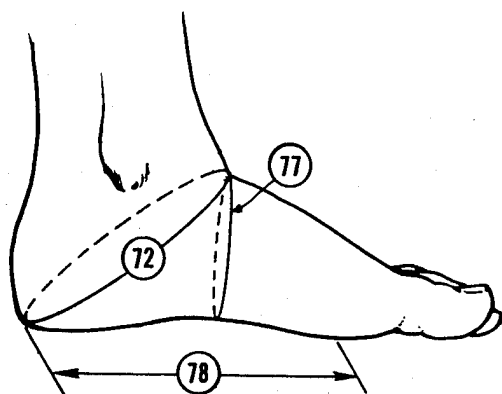
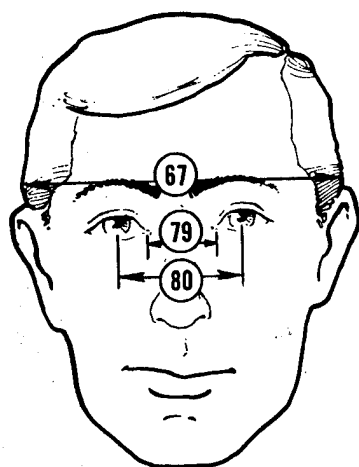
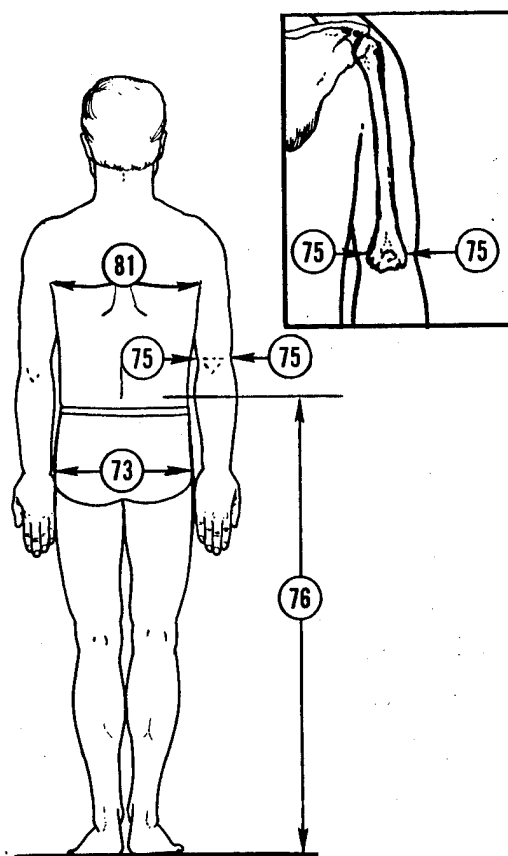
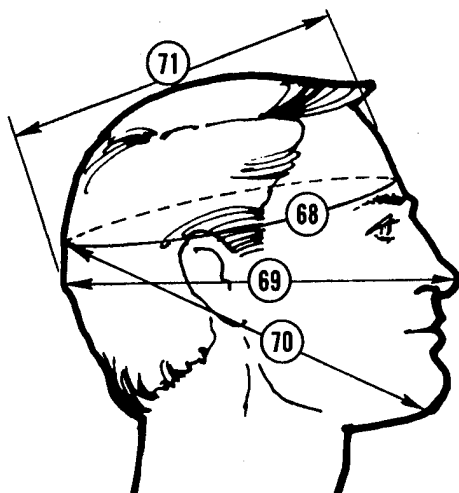




TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	Small	Mid	Large
82 KNEE CIRCUMFERENCE: The horizontal circumference of the knee at the level of the middle of the kneecap (patella).	35.9	39.2	42.1
83 KNEE HEIGHT: The vertical distance between the standing surface and the level of the middle of the kneecap (patella).	46.4	50.0	53.6
84 KNEE HEIGHT, SITTING: The vertical distance between a footrest surface and the top of a knee of a seated subject. The knee is flexed 90 degrees.	52.3	56.2	60.0
*85 LATERAL FEMORAL EPICONDYLE HEIGHT: The vertical distance between the standing surface and the level of the maximum protrusion of the lateral femoral epicondyle.	47.6	51.0	54.3
86 LATERAL MALLEOLUS HEIGHT: The vertical distance between the standing surface and the lateral point of the ankle.	6.6	7.1	7.6
87 LIP LENGTH: The horizontal distance between the outer corners of the lips.	5.1	5.2	5.4
88 LIP PROTRUSION TO WALL: The horizontal distance between the most protruding point of the lips and the plane of the back of the head.	20.7	21.2	21.7
*89 LOWER THIGH CIRCUMFERENCE: The circumference of the thigh just above the kneecap (patella).	38.4	43.7	47.9
90 MAXIMUM FRONTAL (Forehead) BREADTH: The horizontal distance between the lateral ends of the browridges.	11.4	11.6	11.9
91 MEDIAL MALLEOLUS HEIGHT: The vertical distance between the standing surface and the medial point of the ankle.	8.1	8.6	9.1
92 MENTON-SELLION LENGTH (Face Length): The distance between the tip of the chin (menton) and the deepest point of the nasal root depression (sellion).	11.7	12.1	12.4
93 MENTON-SUBNASALE LENGTH: The distance between the tip of the chin (menton) and the base of the nose (subnasale).	6.7	6.9	7.1
94 MENTON TO TOP OF HEAD: The vertical distance between the tip of the chin (menton) and the plane of the top of the head	22.3	22.8	23.3
95 MIDSHOULDER HEIGHT, SITTING: The vertical distance between the sitting surface and the midpoint of the top of the shoulder (half the distance between the lateral base of the neck and acromion).	61.3	65.0	68.6

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

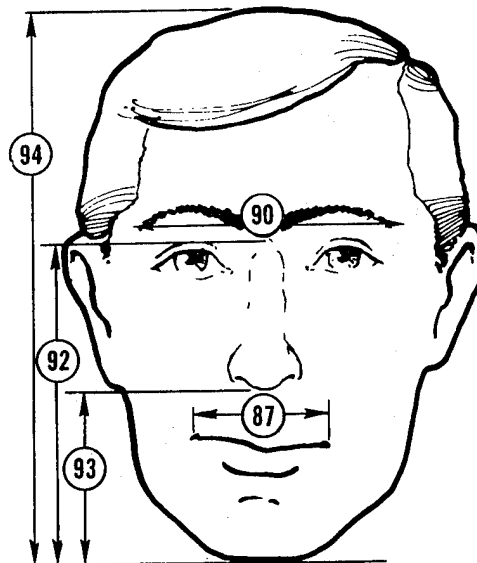
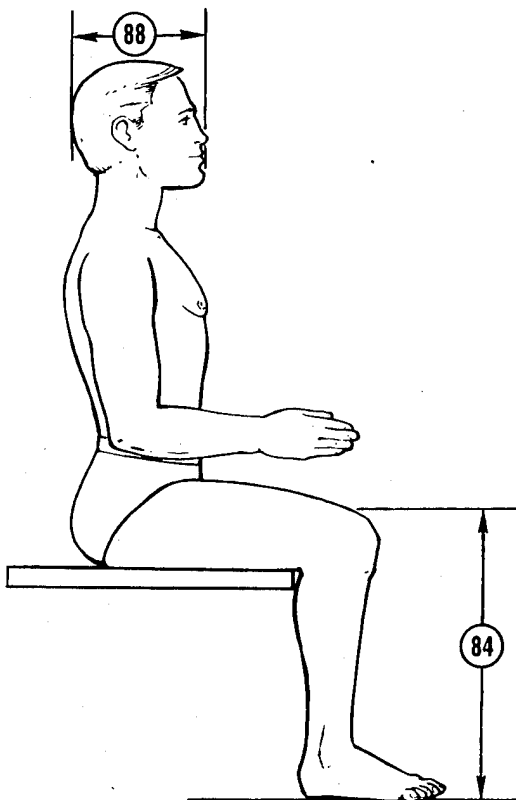
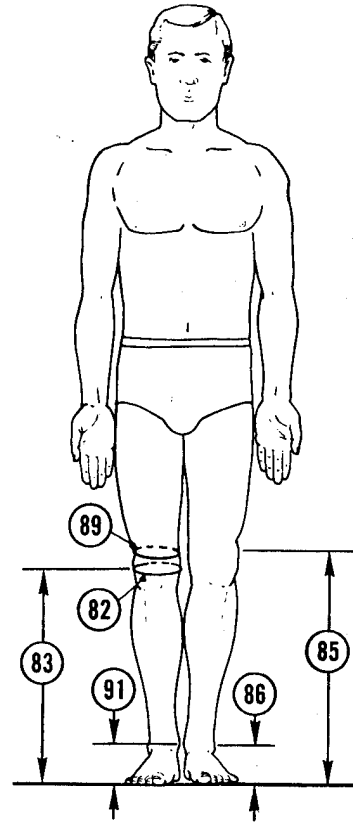
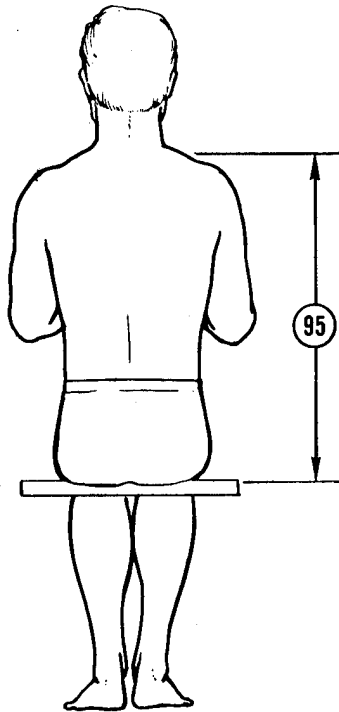


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	Small	Mid	Large
96 MINIMUM FRONTAL ARC: The surface distance between the points of greatest indentation of the temporal crests.	13.4	13.6	13.9
97 NASAL BREADTH: The maximum horizontal breadth of the nose.	3.5	3.6	3.6
*98 NASAL ROOT BREADTH: The horizontal breadth of the root of the nose.	1.5	1.8	2.1
99 NECK CIRCUMFERENCE: The maximum circumference of the neck, including the Adam's apple, perpendicular to its long axis.	36.5	38.7	40.6
100 NOSE LENGTH: The distance between the lowest point of the nasal septum (subnasale) and the deepest point of the nasal root depression (sellion).	5.0	5.1	5.3
*101 NOSE PROTRUSION: The distance between the tip of the nose (pronasale) and the lowest point of the nasal septum (subnasale).	2.0	2.4	2.8
*102 NUCHALE HEIGHT: The vertical distance in the mid-sagittal plane between the standing surface and the lowest palpable bony point of the back of the head (nuchale).	151.2	161.2	170.7
103 PALM LENGTH: The vertical distance between the distal end of the radius (stylion) and the crease at the base of the middle finger.	10.4	10.9	11.4
104 PHILTRUM LENGTH: The length of the groove between the upper lip and the base of the nose.	1.5	1.6	1.6
105 POPLITEAL HEIGHT: The vertical distance between a footrest surface and the lower lateral surface of the thigh, just behind the knee, when the subject is seated with the knee flexed 90 degrees.	41.2	44.0	46.7
106 PRONASALE TO TOP OF HEAD: The vertical distance between the tip of the nose (pronasale) and the plane of the top of the head.	14.5	14.8	15.0
107 PRONASALE TO WALL: The horizontal distance between the tip of the nose (pronasale) and the plane of the back of the head.	**	**	**
108 RADIALE-STYLION LENGTH: The distance, along the long axis of the forearm, between the proximal end of the radius (radiale) and the distal end of the radius (stylion)	25.3	27.1	28.8

\* See section on Body Size, page 6.

\*\* These values deleted due to inconsistency with 121; the 121 values are deemed to be correct.

TABLE 1 (cont'd)

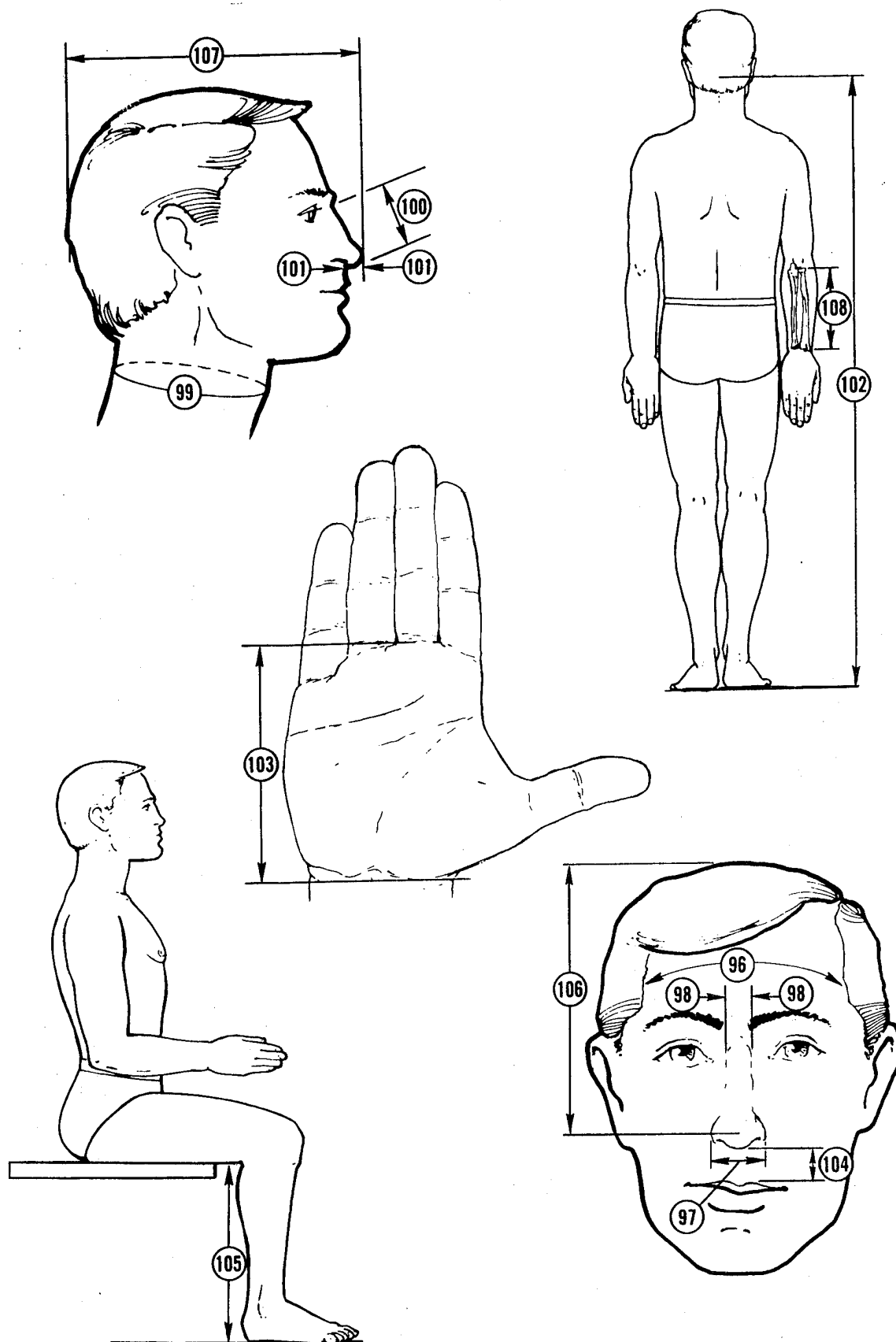


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	Small	Mid	Large
109 SAGITTAL ARC: The surface distance over the top of the head from the point between the browridges (glabella) to the bony point on the back of the head (inion).	34.2	34.7	35.2
110 SCYE CIRCUMFERENCE: The vertical circumference passing over the shoulder and through the highest point of the axilla.	45.1	48.9	52.3
111 SELLION TO TOP OF HEAD: The vertical distance between the deepest point of the nasal root depression (sellion) and the plane of the top of the head.	10.5	10.8	11.0
112 SELLION TO WALL: The horizontal distance between the deepest point of the nasal root depression (sellion) and the plane of the back of the head.	19.8	20.2	20.6
113 SHOULDER CIRCUMFERENCE: The maximum horizontal circumference of the shoulders at the level of the deltoid muscles.	110.6	119.1	126.4
114 SHOULDER-ELBOW LENGTH: The distance, along the long axis of the upper arm, between the tip of the shoulder (acromion) and the bottom of the elbow (olecranon process) when the upper arm is hanging freely with the elbow flexed 90 degrees.	34.0	36.2	38.3
115 SHOULDER LENGTH: The surface distance between the lateral juncture of the base of the neck with the shoulder, and the tip of the shoulder (acromion).	15.8	16.7	17.6
116 SITTING HEIGHT: The vertical distance between the sitting surface and the top of the head.	89.3	93.7	98.0
*117 SPHYRION HEIGHT: The vertical distance between the standing surface and the distal end of the tibia (sphyrion).	6.5	7.0	7.5
118 STATURE: The vertical distance between the standing surface and the top of the head.	168.1	178.4	188.6
119 STOMION TO TOP OF HEAD: The vertical distance between the midpoint of closed lips and the plane of the top of the head.	18.0	18.4	18.8
120 SUBNASALE TO TOP OF HEAD: The vertical distance between the base of the nose (subnasale) and the plane of the top of the head.	15.8	16.1	16.5
121 SUBNASALE TO WALL: The horizontal distance between the lowest point of the nasal septum (subnasale) and the plane of the back of the head.	20.6	21.1	21.5

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

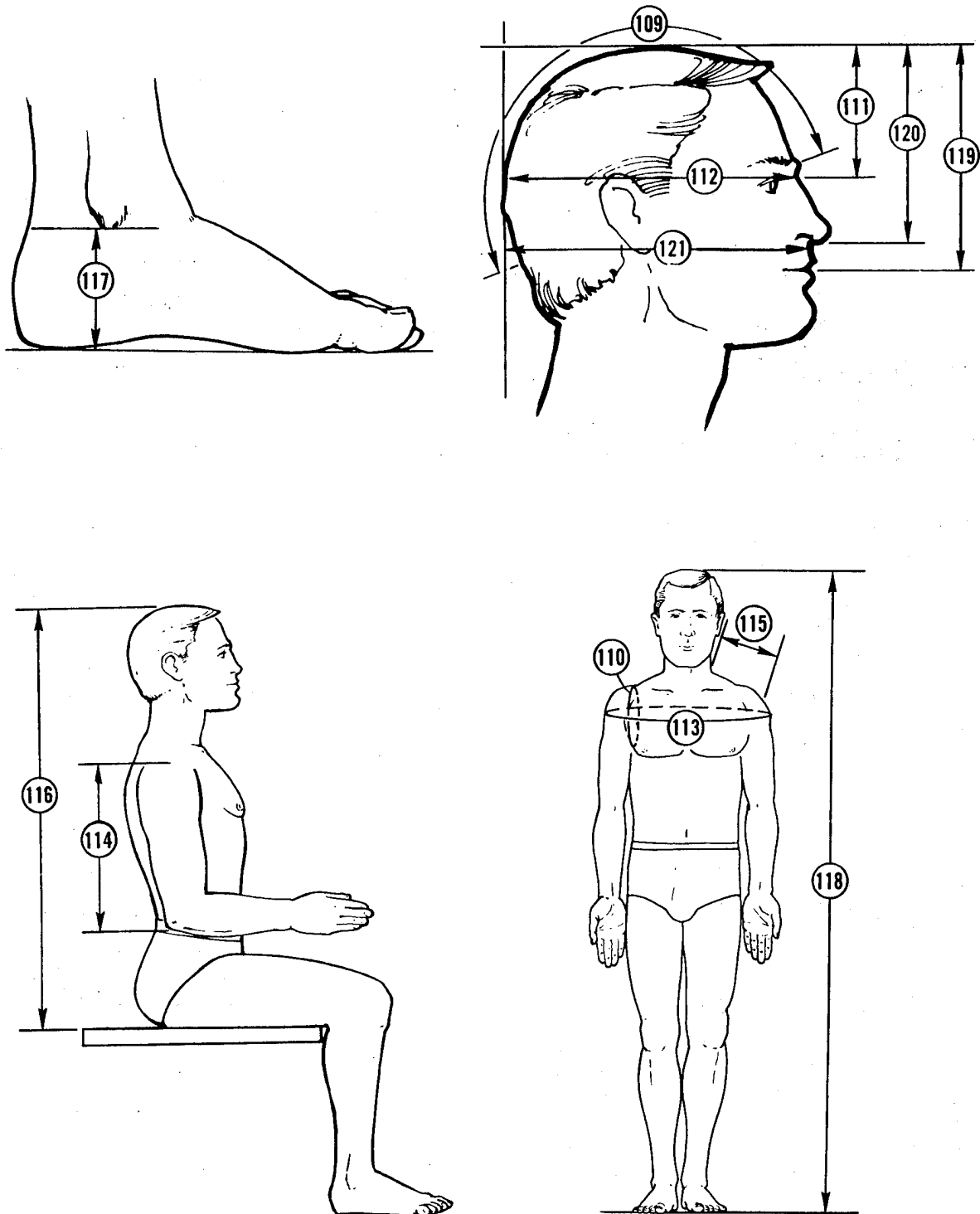


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	Small	Mid	Large
122 SUPRASTERNAL HEIGHT: The vertical distance between the standing surface and the point of deepest depression of the top of the breast-bone (suprasternale).	136.9	146.2	155.3
*123 TENTH RIB HEIGHT: The vertical distance between the standing surface and the level of the lowest point of the tenth rib.	105.1	112.5	119.8
124 THIGH CIRCUMFERENCE: The circumference of the thigh perpendicular to its long axis at the lowest point of the juncture of a buttock with the thigh.	53.7	59.9	65.2
125 THIGH CIRCUMFERENCE, SITTING: The vertical circumference of the thigh at its juncture with the groin of a seated subject.	52.7	58.9	64.2
126 THIGH CLEARANCE: The vertical distance between the sitting surface and the highest point on the thigh of a seated subject.	15.1	16.8	18.3
127 THUMB-TIP REACH: The horizontal distance between the plane of the back (a wall) and the tip of the thumb with an arm extended forward and the tip of the index finger touching the pad of the thumb. The palm is down.	76.0	80.8	85.5
128 THUMB-TIP REACH, EXTENDED: The horizontal distance between the plane of the back (a wall) and the tip of the thumb with an arm and a shoulder extended forward as far as possible while keeping the back of the other shoulder firmly against the wall. The tip of the index finger touches the pad of the thumb. The palm is down.	85.1	90.1	95.1
129 TRAGION TO TOP OF HEAD: The vertical distance between tragon and the plane of the top of the head.	13.2	13.5	13.7
130 TRAGION TO WALL: The horizontal distance between tragon and the plane of the back of the head.	10.2	10.4	10.5
131 TROCHANTERIC HEIGHT: The vertical distance between the standing surface and the top of the greater trochanter of the femur (trochanterion).	88.4	94.6	100.8

\* See section on Body Size, page 6.

TABLE 1 (cont'd)

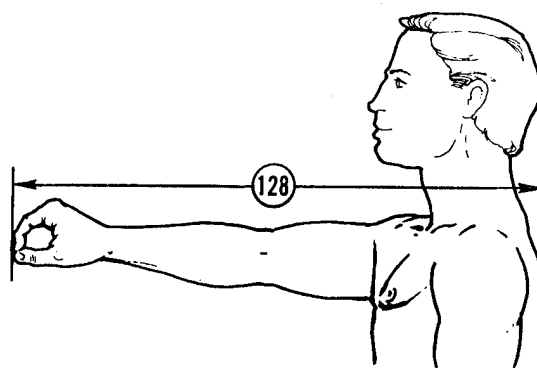
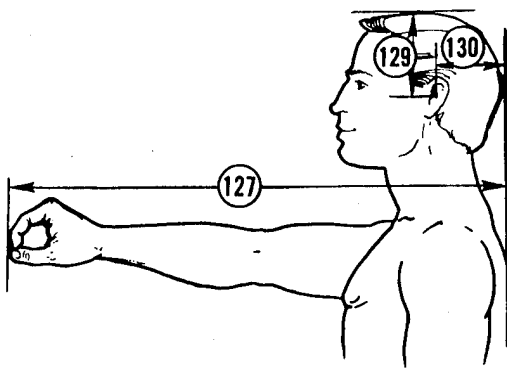
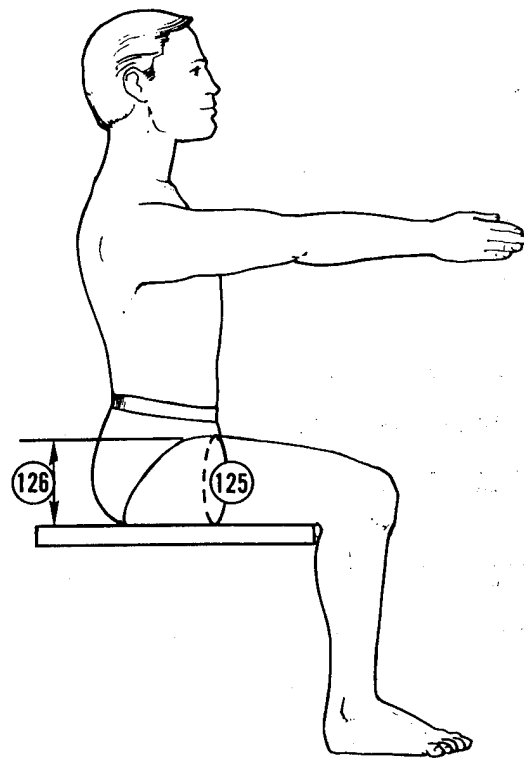
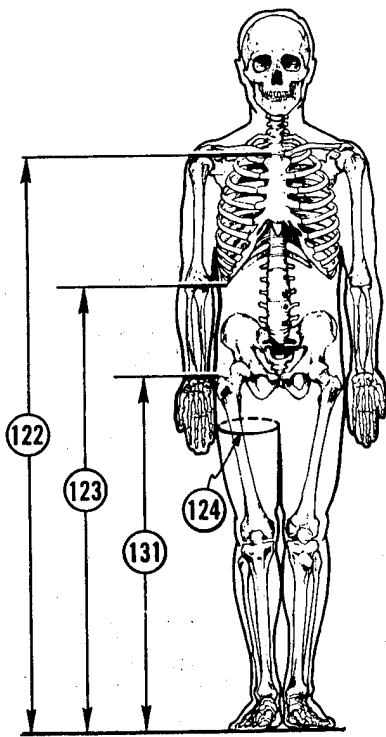


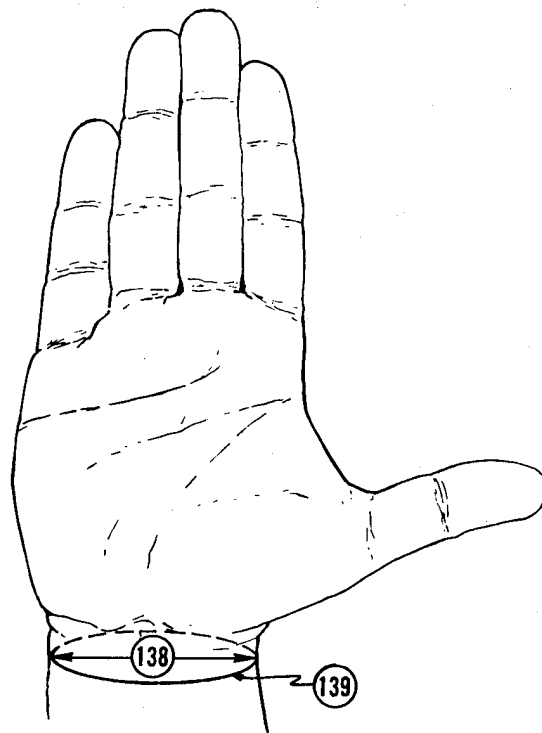
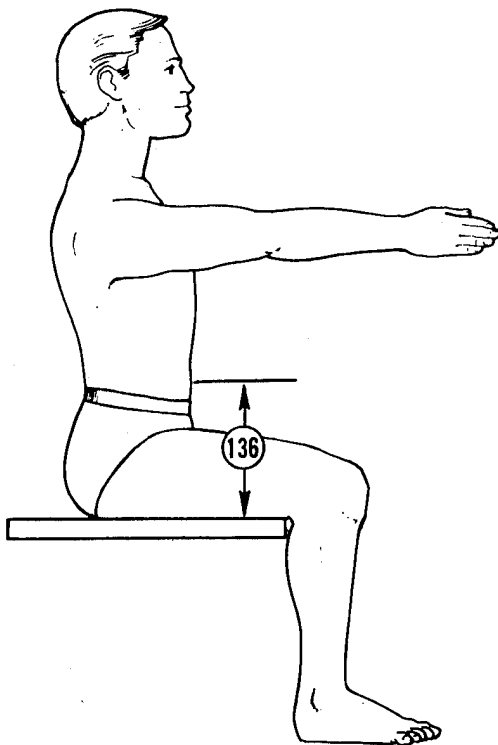
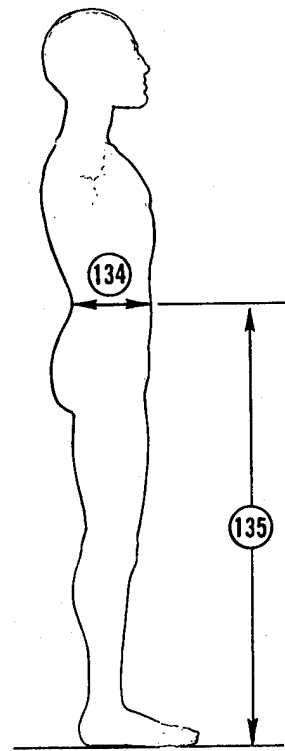
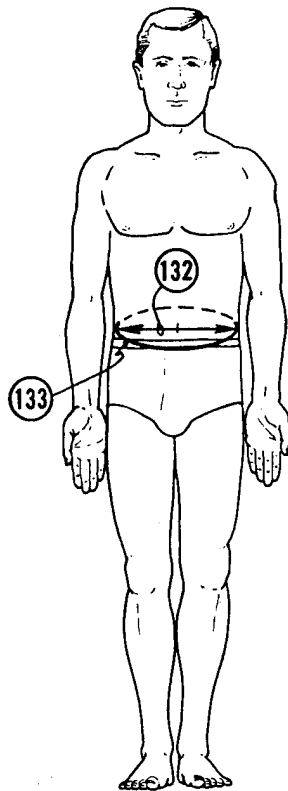


TABLE 1 (cont'd)

Dimension Descriptions	DESIGN VALUES (cm)		
	Small	Mid	Large
132 WAIST BREADTH: The horizontal breadth of the torso at the level of the navel.	28.1	31.5	34.5
133 WAIST CIRCUMFERENCE: The horizontal circumference of the torso at the level of the navel.	79.0	89.4	98.2
134 WAIST DEPTH: The horizontal depth of the torso at the level of the navel.	20.2	22.8	24.9
135 WAIST HEIGHT: The vertical distance between the standing surface and the navel.	100.3	107.2	114.0
*136 WAIST HEIGHT, SITTING: The vertical distance between the seated surface and the navel.	21.5	22.4	23.4
137 WEIGHT: Weight of the subject to the nearest tenth of a pound.	139.5 lbs	179.7 lbs	215.4 lbs
*138 WRIST BREADTH (Bone): The maximum distance between the radial and ulnar styloid processes.	5.3	5.7	6.0
139 WRIST CIRCUMFERENCE: The circumference of the wrist perpendicular to the long axis of the forearm at the level of the distal tip of the radius (stylion).	16.7	17.7	18.7

\* See section on Body Size, page 6.

TABLE 1 (cont'd)



## Body Segmentation

In order to describe its mass distribution properties, the body is segmented by planes as shown in Figure 2. These planes relate to the body in the erect standing position and are identified as described below:

- 1 HEAD PLANE: A plane that passes through the right and left gonion and nuchale.
- 2 NECK PLANE: A compound plane in which a horizontal plane through cervicale intersects anteriorly with a second plane. The second plane passes through the lower of the two clavicle landmarks, is perpendicular to the mid-sagittal plane, and makes a 45-degree angle with the horizontal plane.
- 3 THORAX PLANE: A horizontal plane that passes through the 10th rib midspine landmark.
- 4 ABDOMINAL PLANE: A horizontal plane passing through the higher of the two iliac crest landmarks.
- 5 HIP PLANE: A plane perpendicular to the frontal plane passing through the center of the crotch and the midpoint between the anterior superior iliac spine landmark and trochanterion.
- 6 KNEE PLANE: A horizontal plane passing through the lateral femoral epicondyle.
- 7 ANKLE PLANE: A horizontal plane passing through the sphyrion landmark.
- 8 SHOULDER PLANE: A plane passing through the acromion landmark and the anterior and posterior scye point marks of the axillary folds.
- 9 ELBOW PLANE: A plane passing through the olecranon process and the medial and lateral humeral epicondyle landmarks.
- 10 WRIST PLANE: A plane perpendicular to the long axis of the forearm passing through the radial styloid landmark.

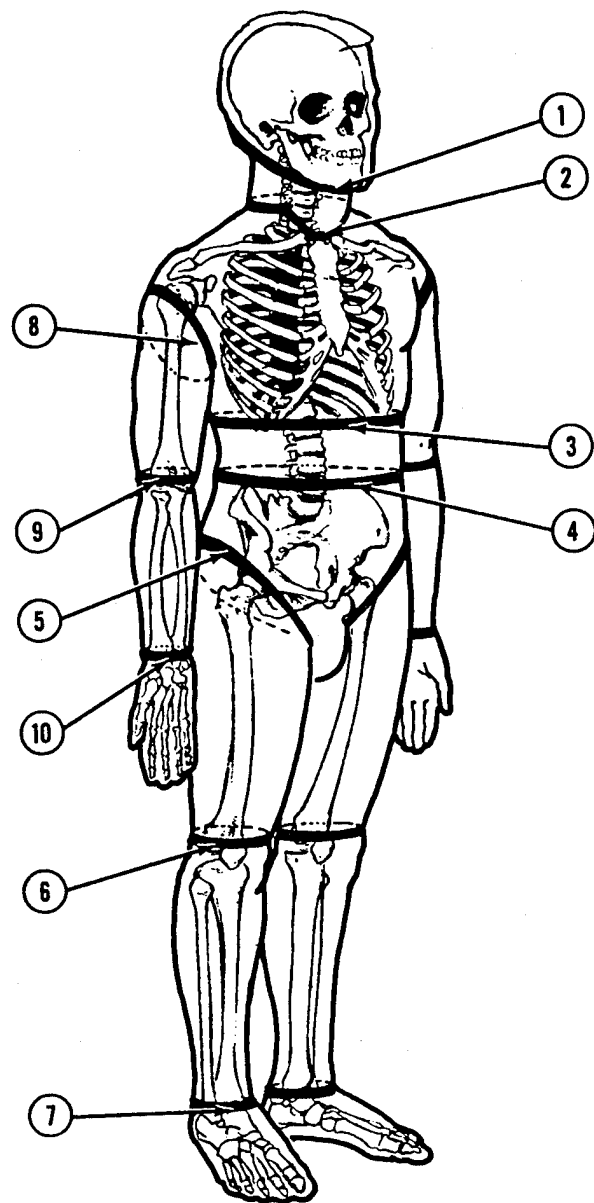


Figure 2. Planes of body segmentation.

## Mass Distribution

The mass distribution data were calculated from regression equations reported in McConville et al. (1980). These data are based upon a stereophotometric assessment of volume. The assumption that the distribution of volume can be substituted for the distribution of mass is supported by the data reported in Young et al. (1983). The reader is referred there for more information.

The alignment of principal axes for each segment, the mass, and principal moments of inertia (calculated with respect to the segment center of mass) are presented in Table 2. A general assumption of body symmetry with respect to the midsagittal plane has been made so that properties of right and left segments are identical.

For purposes of specifying the segmental principal axes directions, a whole body reference axis system (r) is defined. This reference system is based on a standing surface in which the  $X_r$  axis points anteriorly, the  $Y_r$  axis to the left and the  $Z_r$  axis vertically upward.

The neck, thorax, and pelvis principal axes are rotated from this reference position, as shown in Table 2. The principal axes for the extremity segments (with the exception of the hand and foot) are such that the  $Z_p$  axis is aligned with the long axis of the bones and the  $X_p$  and  $Y_p$  axes are perpendicular to it with no preferred direction since the  $X_p$  and  $Y_p$  principal moments are equal. The orientation of the principal axes for the hand and foot are coincident with the reference axes.

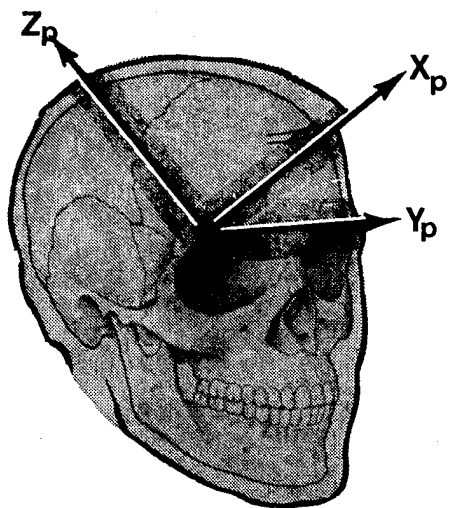
For the head, a local anatomically defined coordinate system (a) is used as the reference coordinate system. It is defined by the  $Y_a$  axis running from the right trigion to the left trigion, the  $X_a$  axis being the normal vector from the  $Y_a$  axis to the right infraorbitale, the  $Z_a$  axis being formed by the cross product of the  $X_a$  and  $Y_a$  axes vectors, and the origin being located on a line connecting the trignons ( $Y_a$ ) at a point closest to sellion. The relative orientation of the head principal axes to the anatomical axes (a) is shown in Figure 3. For the head, the  $X_p$  axis is rotated  $36^\circ$  counterclockwise about the  $Y_a$  axis (see Table 2).

## Segmental Masses

The segmental masses were determined from the relative proportions of segmental volumes obtained from regression equations developed by McConville et al. (1980), and total body masses of 63.3 kilograms for the Small sized man, 81.5 kilograms for the Mid-sized man and 97.7 kilograms for the Large sized man.

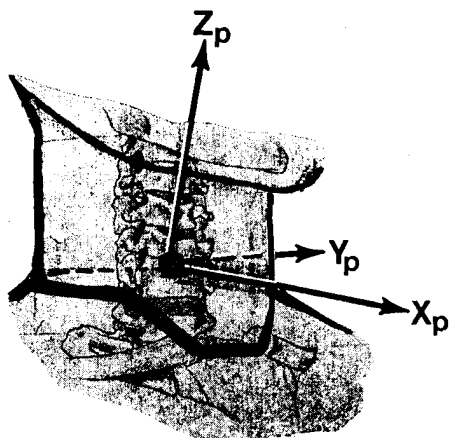
TABLE 2

MASS DISTRIBUTION OF THE BODY SEGMENTS  
 (mass in kilograms; moments of inertia in kilograms/cm<sup>2</sup>;  
 X is anterior; positive rotation is clockwise)



HEAD				
	Segment Mass	Moments		
		X	Y	Z
SMALL	4.0	193	219	144
MID-SIZE	4.2	206	235	153
LARGE	4.4	218	250	161

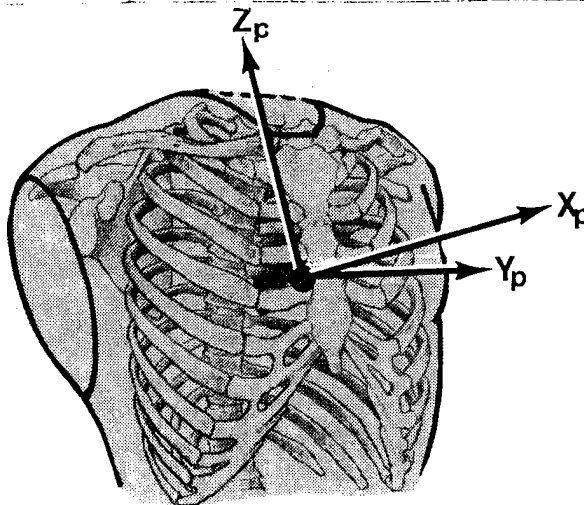
The principal axes are rotated  
 -36° about the Y<sub>a</sub> axis.



NECK				
	Segment Mass	Moments		
		X	Y	Z
SMALL	0.9	13	16	19
MID-SIZE	1.1	18	22	28
LARGE	1.2	23	27	35

The principal axes are rotated  
 +22.2° about the Y<sub>r</sub> axis.

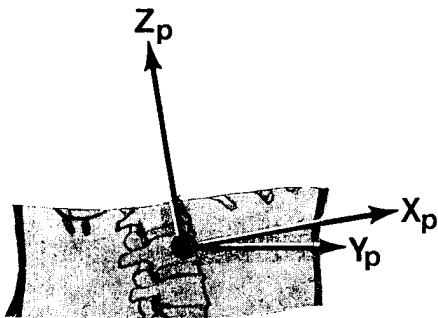
TABLE 2 (cont'd)



## THORAX

	Segment Mass	Moments		
		X	Y	Z
SMALL	18.6	3233	2347	1975
MID-SIZE	24.9	5224	3857	3284
LARGE	30.5	7002	5202	4432

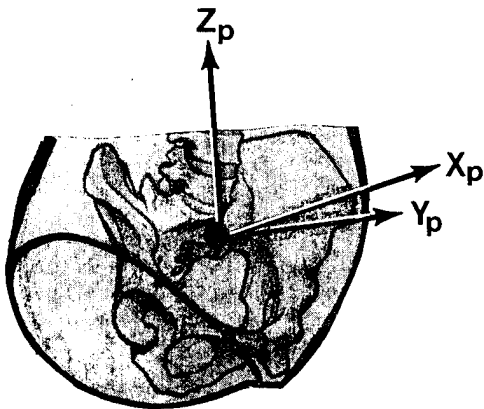
The principal axes are rotated  
-12° about the  $Y_r$  axis.



## ABDOMEN

	Segment Mass	Moments		
		X	Y	Z
SMALL	1.9	108	58	160
MID-SIZE	2.4	175	99	266
LARGE	2.9	233	133	356

The principal axes are coincident  
with the reference axes.

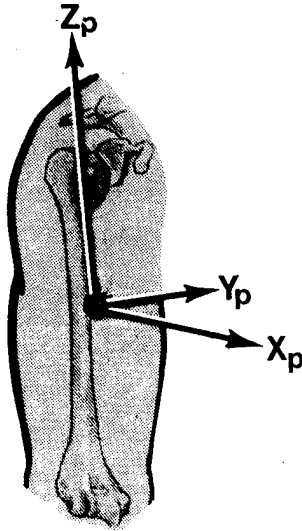


## PELVIS

	Segment Mass	Moments		
		X	Y	Z
SMALL	8.6	651	587	746
MID-SIZE	11.8	1116	1028	1298
LARGE	14.6	1519	1408	1773

The principal axes are rotated  
-24° about the  $Y_r$  axis.

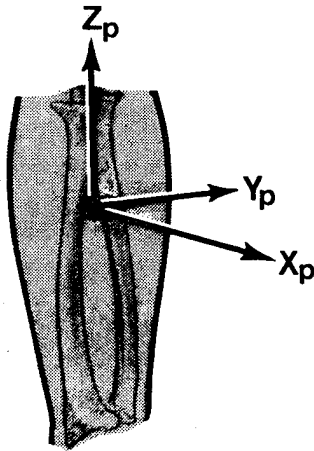
TABLE 2 (cont'd)



## UPPER ARM

	Segment Mass	Moments		
		X	Y	Z
SMALL	1.5	85	85	17
MID-SIZE	2.0	141	141	29
LARGE	2.4	192	192	39

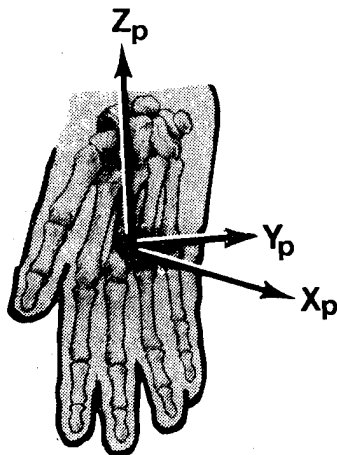
The  $Z_p$  axis is coincident with the  $Z_r$  axis and the  $X_p$  and  $Y_p$  axes are degenerate.



## FOREARM

	Segment Mass	Moments		
		X	Y	Z
SMALL	1.1	61	61	9
MID-SIZE	1.4	90	90	14
LARGE	1.6	117	117	18

The  $Z_p$  axis is coincident with the  $Z_r$  axis and the  $X_p$  and  $Y_p$  axes are degenerate.



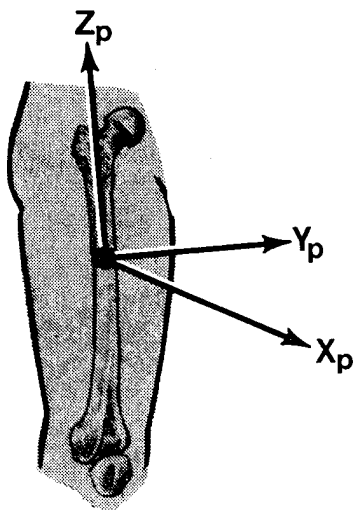
## HAND

	Segment Mass	Moments		
		X	Y	Z
SMALL	0.5	10	8	3
MID-SIZE	0.5	13	11	4
LARGE	0.6	16	13	5

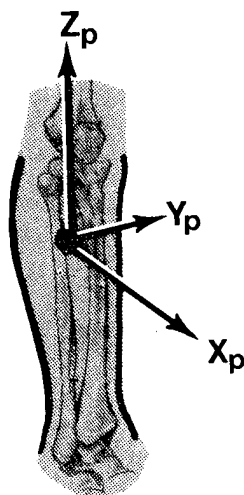
The principal axes are coincident with the reference axes with the hand aligned as shown in Figure 1.



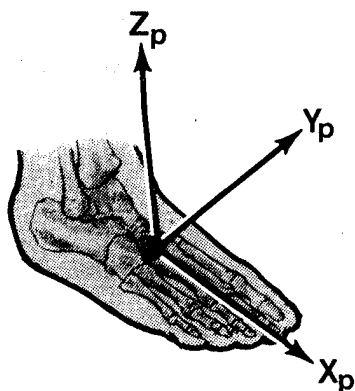
TABLE 2 (cont'd)



THIGH				
	Segment	Moments		
	Mass	X	Y	Z
SMALL	7.7	1093	1093	289
MID-SIZE	9.8	1652	1652	452
LARGE	11.8	2175	2175	595
The $Z_p$ axis is coincident with the $Z_r$ axis and the $X_p$ and $Y_p$ axes are degenerate.				



CALF				
	Segment	Moments		
	Mass	X	Y	Z
SMALL	3.1	406	406	48
MID-SIZE	3.8	606	606	71
LARGE	4.5	798	798	92
The $Z_p$ axis is coincident with the $Z_r$ axis and the $X_p$ and $Y_p$ axes are degenerate.				



FOOT				
	Segment	Moments		
	Mass	X	Y	Z
SMALL	0.8	6	31	33
MID-SIZE	1.0	8	44	46
LARGE	1.1	11	56	59
The principal axes are coincident with the reference axes with the feet aligned as shown in Figure 1.				

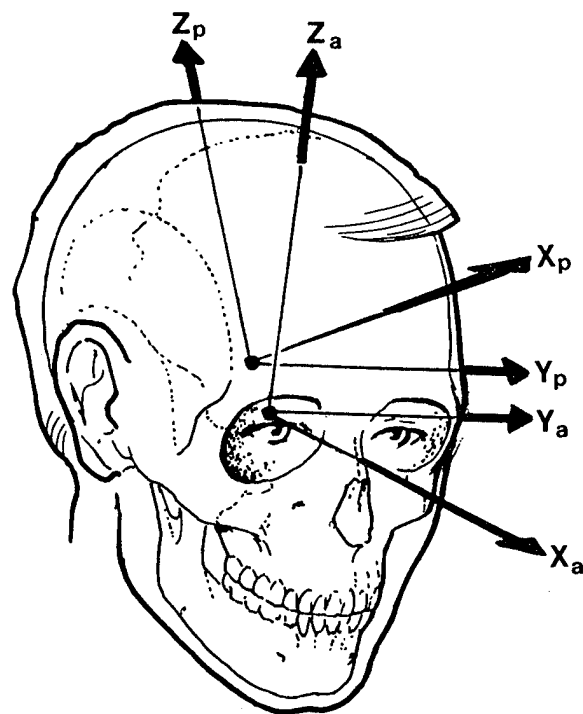


Figure 3. Principal axis orientation for the head relative to the anatomical axis system.

### Body Linkage and Center of Mass (CM) Locations

Figures 4 through 9 illustrate the location of the centers of mass and joint centers for body segments for the Small, the Mid, and the Large sized male aviator. The centers of mass of the body segments with respect to their adjacent joint centers are assumed not to change from the standing to the seated position.

With the exception of the head, the centers of mass locations are based on the stereophotometric assessments of McConville et al. (1980). The location of the head center of mass is based on both the McConville data and that of Beier et al. (1979) and is similar to that derived by Robbins (1983).

The inserts in Figures 4, 6, and 8 show the estimated location of the trochanterion landmark with respect to the seated surface and a vertical plane tangent to the posterior surface of the buttock for an erect, seated posture. These data are based upon the data developed by Geoffrey (1961).

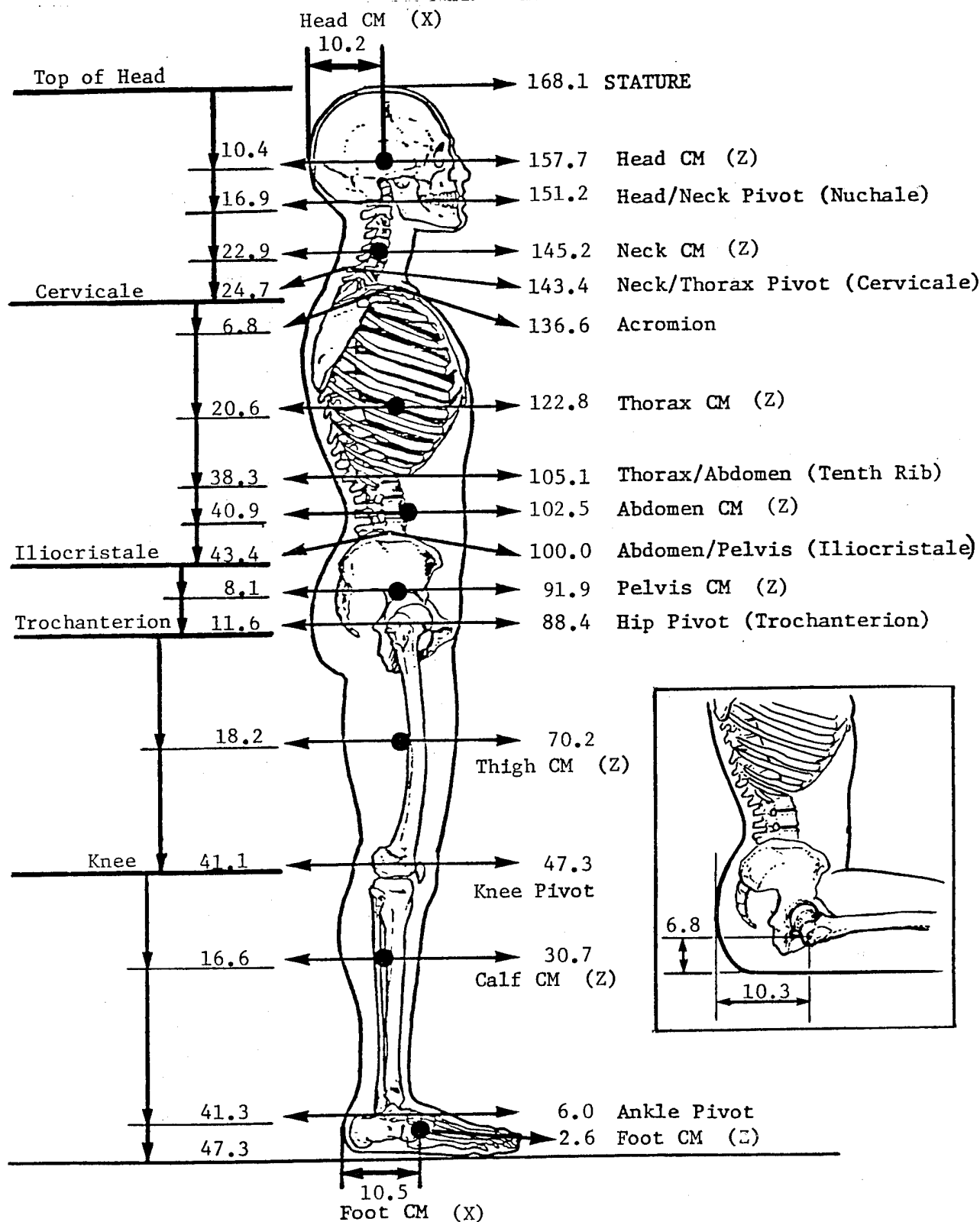


Figure 4. Body linkage and centers of mass (excludes arms) for the Small male aviator. Units are in centimeters.

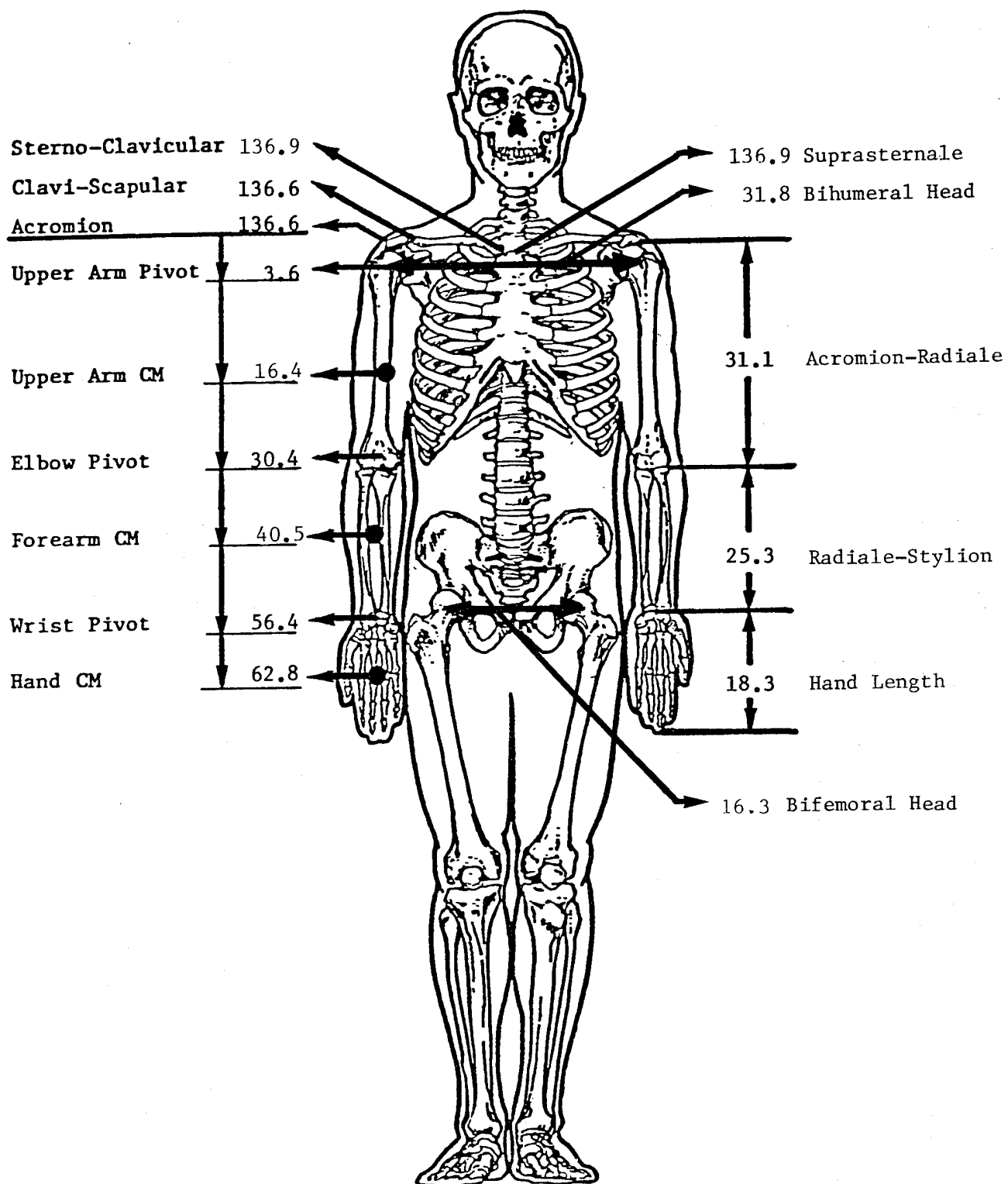


Figure 5. Centers of mass and linkage for the arms of the Small male aviator. Units are in centimeters.

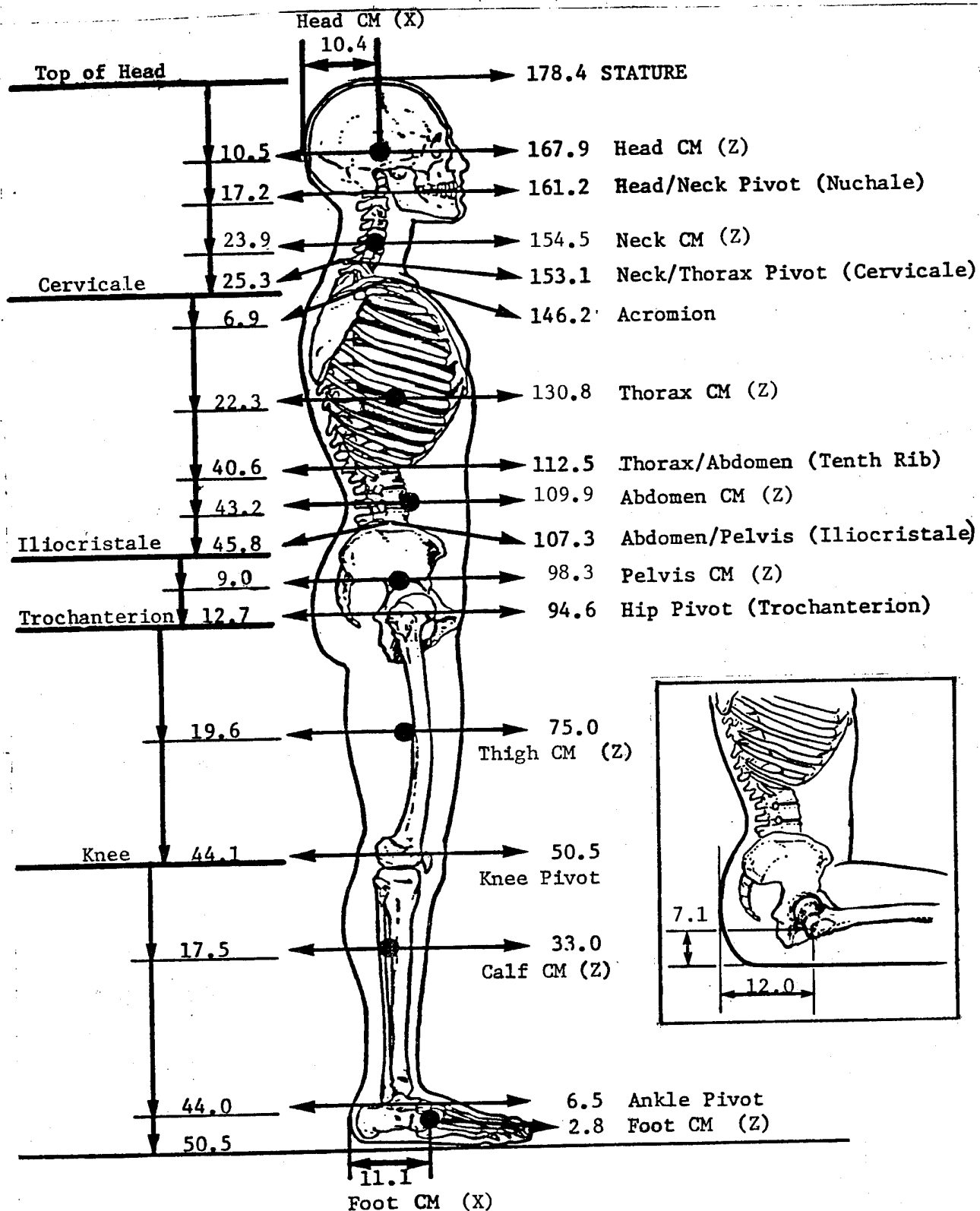


Figure 6. Body linkage and centers of mass (excludes arms) for the Mid-size male aviator. Units are in centimeters.

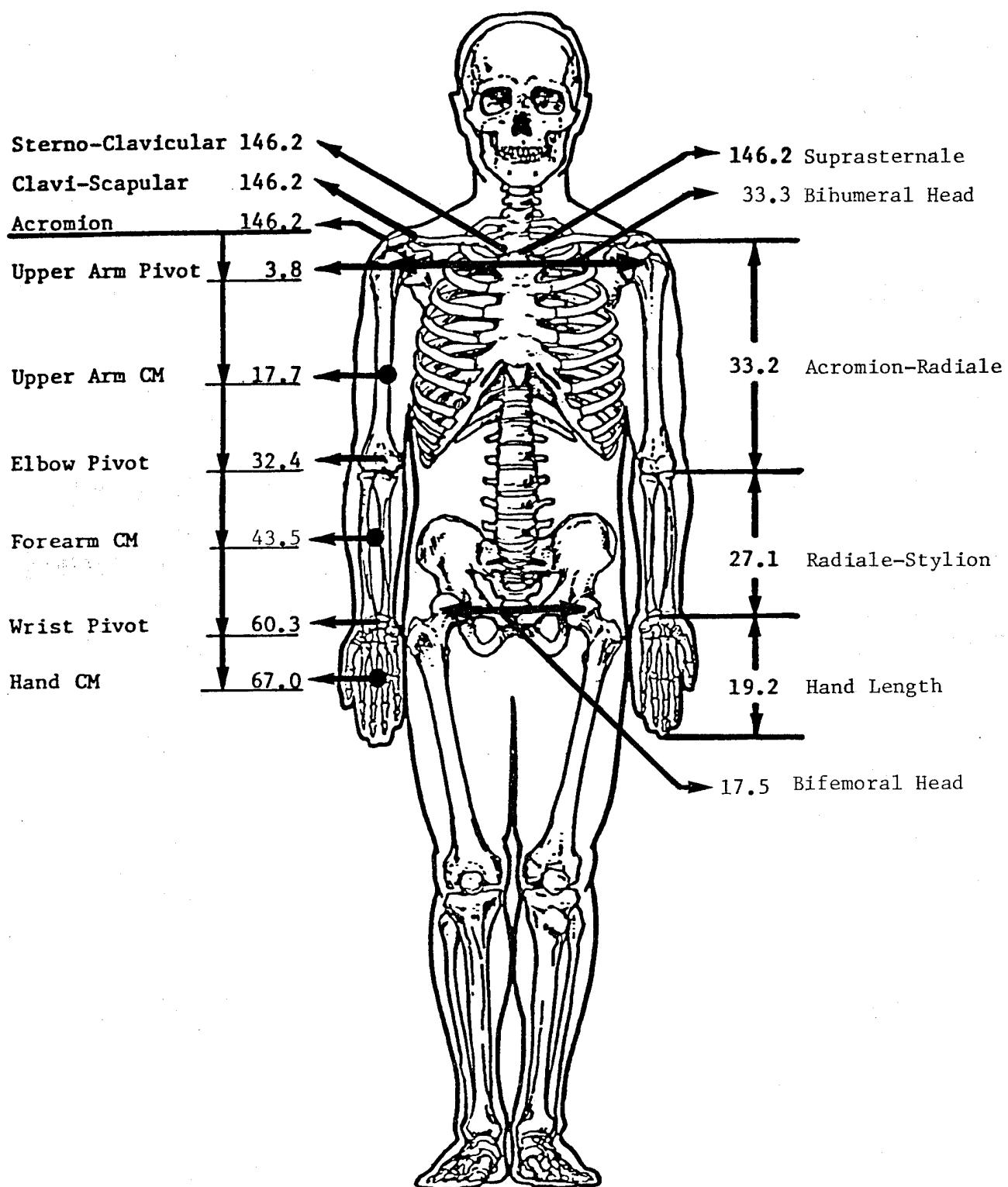


Figure 7. Centers of mass and linkage for the arms of the Mid-size male aviator. Units are in centimeters.

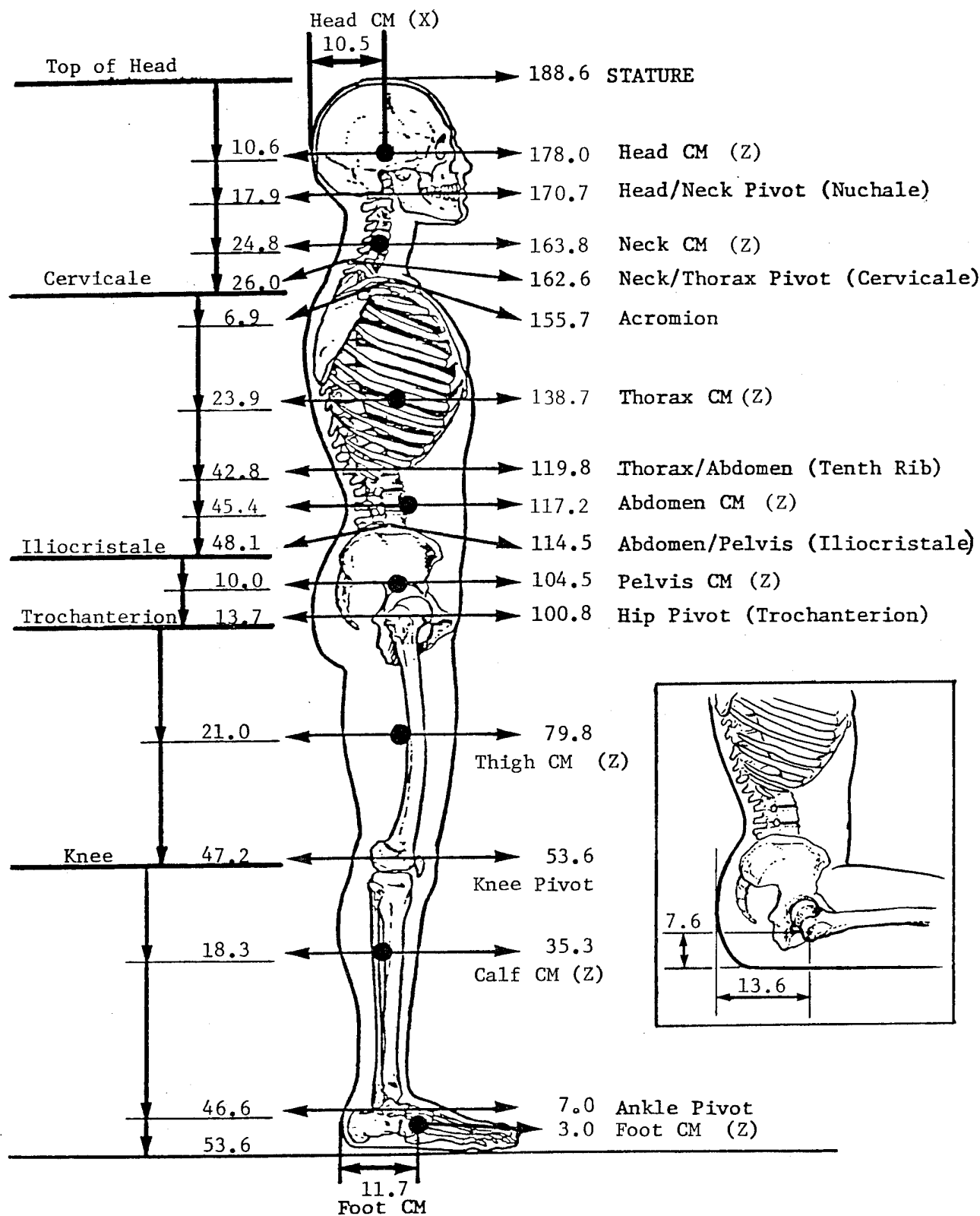


Figure 8. Body linkage and centers of mass (excludes arms) for the Large male aviator. Units are in centimeters.



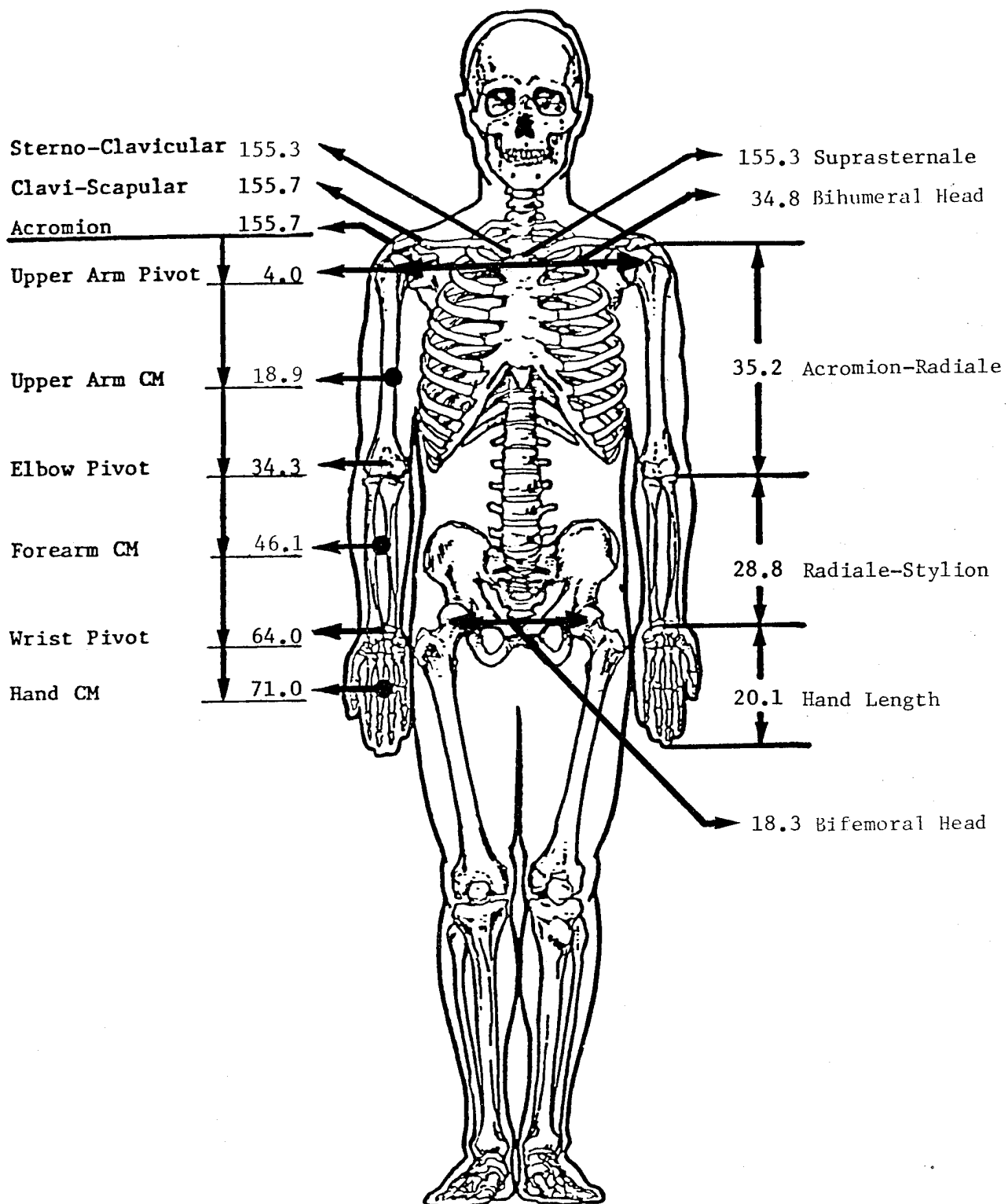


Figure 9. Centers of mass and linkage for the arms of the Large male aviator. Units are in centimeters.

## DEFINITIONS

ABDOMEN:	As defined in this document, the abdomen is that segment of the torso bounded superiorly by a horizontal plane passing through the lowest point of the 10th rib and inferiorly by a horizontal plane passing through iliocristale.
ACROMION:	The lateral point on the bony tip of the shoulder.
ANTERIOR:	Pertaining to the front of the body; as opposed to posterior (see Figure 1).
ANTERIOR SUPERIOR ILIAC SPINE	The anterior end point of the crest of an ilium.
AXILLARY FOLDS:	The anterior and posterior folds formed by the juncture of the upper arms and the torso.
BI:	A prefix relating to each of two symmetrically paired points.
BICEPS (Brachii M.):	The large muscle on the anterior side of the upper arm.
BICRISTAL:	Pertaining to the crests of the ilia.
BIFEMORAL HEAD BREADTH:	The horizontal distance between the center of the head of the right and left femur. (Estimates derived from cadaveric material.)
BIHUMERAL HEAD BREADTH:	The horizontal distance between the center of the head of the right and left humerus. (Estimates derived from cadaveric material.)
CERVICALE:	The superior point on the spinous process of the 7th cervical vertebra.
CLAVICALE:	The superior point of the medial end of the clavicle.
CORONAL:	Pertaining to the crown of the head.
DACTYLION:	The tip of the middle finger.
DELTOID MUSCLE:	A large muscle passing over the top of the shoulder and inserting into the upper half of the humerus.
DISTAL:	The end of a body segment furthest from the torso; the opposite of proximal (see Figure 1).

ECTOCANTHUS:	The point of the juncture of the eyelids at the lateral corner of an eye.
ENDOCANTHUS:	The inner corner of an eye.
EPICONDYLES:	Bony eminences at the distal ends of the humerus and femur.
FEMUR:	The thigh bone.
FRANKFORT PLANE:	The standard horizontal plane or orientation of the head. The plane passes through the right tragion and the lowest point of the right eye socket.
FRONTOTEMPORALE:	The point of greatest indentation of the temporal crests.
GLABELLA:	The anterior point in the midsagittal plane between the eyebrows.
GONION:	The lateral point of the obtuse angle at the back of the lower jaw formed by the intersection of the vertical and horizontal portions of the jaw.
HUMERUS:	The upper arm bone.
ILIOCRISTALE:	A point in the midaxillary line on the crest of the ilium. The point is midway between the superior and lateral margins of the crest.
ILIUM (ILIA pl.):	The upper one of three bones composing either half of the pelvis.
INFERIOR:	Lower, nearer to the feet (see Figure 1).
INFRAORBITALE:	Inferior point of the orbit of the eye.
INION:	A protuberance of the occiput (the posterior bone of the skull) located in the center of the lower back of the head.
LANDMARK:	A mark placed on the body or a body surface feature used to identify the origin, end-point, or level of a measurement.
LATERAL:	Lying away from the midsagittal plane of the body; opposed to medial (see Figure 1).
LATERAL FEMORAL EPICONDYLE LANDMARK:	The lateral point on the lateral femoral epicondyle.
LATERAL HUMERAL EPICONDYLE LANDMARK:	The lateral point of the lateral humeral epicondyle.

**LATERAL MALLEOLUS:** The bony prominence at the distal end of the fibula.

**LATERAL MALLEOLUS LANDMARK:** The lateral point of the lateral malleolus.

**MASTOID PROCESS:** An inferior process of the temporal bone palpable just behind the ear.

**MEDIAL:** Lying near the midsagittal plane of the body; opposed to lateral.

**MEDIAL HUMERAL EPICONDYLE LANDMARK:** The medial point of the medial humeral epicondyle.

**MEDIAL MALLEOLUS:** The bony prominence at the distal end of the tibia.

**MEDIAL MALLEOLUS LANDMARK:** The medial point of the medial malleolus.

**MENTON:** The point of the tip of the chin in the midsagittal plane.

**METACARPAL:** One of five long bones of the palm of the hand. Numbered sequentially from I (thumb) through V (little finger).

**METATARSAL:** One of five long bones in the instep of the foot. Numbered sequentially from I (big toe) through V (little toe).

**MIDAXILLARY LINE:** A vertical line on the torso dividing it into front and back portions. The line originates at the center of the axilla.

**MIDSAGITTAL PLANE:** The vertical plane which divides the body into right and left halves.

**NUCHALE:** The lowest palpable bony point in the midsagittal plane of the back of the head.

**OCCIPUT:** Pertaining to the occiput, the bone making up the inferior part of the back of the skull.

**OLECRANON PROCESS:** The curved, hook-like head of the ulna that is the bony part of the back of the elbow. When the elbow is flexed 90 degrees, vertical measurements to the elbow are made to the bottom and horizontal measurements to the elbow are made to the back of the olecranon process.

**PATELLA:** The kneecap.

PHALANGES:	The bones in each of the fingers and toes.
PHILTRUM:	The vertical groove between the upper lip and the bottom of the nose (subnasale).
POPLITEAL:	Pertaining to the posterior surface of the knee.
POSTERIOR:	Pertaining to the back of the body; opposed to anterior.
PRONASALE:	The anterior point of the nose.
PROXIMAL:	The end of a body segment nearest the torso; opposed to distal.
RADIALE:	The lateral point of the head of the radius.
RADIUS:	One of the two bones of the forearm. It is on the thumb side of the upper extremity.
SELLION:	The lowest point in the midsagittal plane of the nasal root depression.
SCYE:	A tailoring term denoting the armhole of a garment. Scye points are the inferior points of the anterior and posterior axillary folds.
STYLION:	The distal point of the radius.
SPHYRION:	The distal point of the tibia.
SUBNASALE:	The point in the midsagittal plane at the juncture of the nasal septum with the philtrum.
SUPRASTERNALE:	The lowest point of the notch of the proximal end of the breastbone (manubrium).
TEMPORAL CREST:	A protruding ridge on the right and left sides of the frontal bone (the major anterior bone of the skull primarily underlying the forehead). It originates at the outside of a browridge and runs in a generally upwards and then backwards direction, where it becomes the inferior temporal line along the side of the skull.
TENTH RIB MIDSPINE LANDMARK:	A mark placed on the spine at the mean level of the inferior points of the right and left 10th ribs.
TIBIA:	The shinbone.

TRAGION:

The superior point of the tragus (the cartilaginous flap in front of the ear).

TROCHANTERION:

The highest point of the greater trochanter (a large, blunt bony process on the lateral side of the proximal end of the femur).

## BIBLIOGRAPHY

Beier, G., M. Schuck, E. Schuller and W. Spann. Determination of Physical Data of the Head: 1. Center of Gravity and Moments of Inertia of Human Heads. Scientific Report, Office of Naval Research, Contract N 000 14-75-c-0486 (AD 080 333). Institute of Forensic Medicine, University of Munich, D-8000 Munich, West Germany, April 1979.

Brantigan, O.C. Clinical Anatomy. McGraw-Hill Book Company, New York. 1963.

Chandler, R.F. and J. Young. Uniform Mass Distribution Properties and Body Size Appropriate for the 50th Percentile Male Aircrew Member During 1980-1990. Memo Report No. AAC-119-81-4. Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, Oklahoma. 1981.

Churchill, Edmund and John T. McConville. Sampling and Data Gathering Strategies for Future USAF Anthropometry. Technical Report AMRL-TR-74-102 (AD A025 240). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1976.

Churchill, Edmund, Paul Kikta and Thomas Churchill. The AMRL Anthropometric Data Bank Library: Volumes I-V. Technical Report AMRL-TR-77-1 (AD A047 314). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1977.

Clauser, Charles E., John T. McConville and J.W. Young. Weight, Volume and Center of Mass of Segments of the Human Body. Technical Report AMRL-TR-69-70 (AD 710 622). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1969.

Daniels, Gilbert S. The "Average Man"? Technical Note WCRD-53-7 (AD 102 03). Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. 1952.

Dempster, W.T. Space Requirements of the Seated Operator. Technical Report, WADC-TR-55-159 (AD 87 895). Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1955.

Geoffrey, S.P. A 2-D Mannikin--The Inside Story, X-Rays Used to Determine A New Standard for A Basic Design Tool. Preprint of paper presented at the 1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, Michigan, January 9-13, 1961.

McConville, John T. and Lloyd L. Laubach. Anthropometry. Chapter III in Anthropometric Source Book, Volume I: Anthropometry for Designers. NASA Reference Publication No. 1024 (NTIS - HC A99/MF A01 CSCL 05H). National Aeronautics and Space Administration, Scientific and Technical Information Office. 1978.

McConville, John T., Thomas D. Churchill, Ints Kaleps, Charles E. Clauser and Jaime Cuzzi. Anthropometric Relationships of Body and Body Segment Moments of Inertia. Technical Report AFAMRL-TR-80-119 (AD A097 238). Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. 1980.

Robbins, D.H. Development of Anthropometrically Based Design Specifications for an Advanced Adult Anthropomorphic Dummy Family. Vol. I in Anthropometry of Motor Vehicle Occupants. Final Report No. UMTRI-83-53-2. U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. 1983.

Reynolds, H.M. The Inertial Properties of the Body and Its Segments. Chapter IV in Anthropometric Source Book, Volume I: Anthropometry for Designers. NASA Reference Publication No. 1024 (NTIS - HC A99/MF A01 CSCL 05H). National Aeronautics and Space Administration, Scientific and Technical Information Office. 1978.

Singley, G.T. and J.L. Haley. The Use of Mathematical Modeling in Crashworthy Helicopter Seating Systems. Paper A22-1 in NATO-AGARD Conference 253, Models and Analogues for the Evaluation of Human Biodynamic Response, Performance, and Protection. Neuilly sur Seine, France. No date.

Young, Joseph W., Richard F. Chandler, Clyde C. Snow, Kathleen M. Robinette, Gregory F. Zehner and Maureen S. Lofberg. Anthropometric and Mass Distribution Characteristics of the Adult Female. Technical Report No. FAA-AM-83-16. Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, Oklahoma. 1983.



Distribution

International University  
Box 97751  
TsT Kowloon, Hong Kong

Medical Librarian  
Israel Air Force  
Aeromedical Center  
Tel Hashomer, Isreal

Commander  
U.S. Army Natick Research  
and Development Center  
ATTN: Documents Librarian  
Natick, MA 01760

Commander  
U.S. Army Natick Research  
and Development Laboratories  
ATTN: DRDNA-YB  
Natick, MA 01760

Francis A. Countway  
Library of Medicine  
10 Shattuck Street  
Boston, MA 02115

Mathematician  
NUSC (Code 2212, B1171-1)  
Newport, RI 02841

COL Vance H. Marchbanks, Jr.  
31 Woodland St., Apartment 10-D  
Hartford, CT 06105

J. Friedman, D.D.S.  
Demetron Research Corp.  
5 Ye Olde Road  
Danbury, CT 06810

Aeromedical Library  
Japan Air Self Defense Force  
1-2-10 SAKAE-CHO  
Tachikawa-shi Tokyo, Japan

Dr. Benjamin Ricc  
Department of Exercise Science  
Boydon 230  
University of Massachusetts  
Amherst, MA 01003

Commander  
U.S. Army Research Institute  
of Environmental Medicine  
Natick, MA 01760

Kent B. Pandolf, Ph.D.  
U.S. Army Research Institute  
of Environmental Medicine  
ATTN: SGRD-UE-ME  
Natick, MA 01760

Commanding Officer  
Israel Air Force  
Aeromedical Center  
Military P.O. B  
Zahal, Isreal 02166

Naval Submarine Medical  
Research Laboratory  
Medical Library, Naval Sub Base  
Box 900  
Groton, CT 05340

Commanding Officer  
Naval Submarine Med Res Lab  
Naval Submarine Base, New London  
Box 900  
Groton, CT 06349-5900

U.S. Army Research and Development  
Support Activity  
Fort Monmouth, NJ 07703

Commander/Director  
U.S. Army Combat Surveillance  
& Target Acquisition Laboratory  
ATTN: DELCS-D  
Fort Monmouth, NJ 07703-5304

Dr. Edwin Hendler  
8 Sandringham Place  
Cherry Hill, NJ 08003

Flight Surgeon's Office  
57 FIS/SGPB  
APO New York 09057-5000

USAF Hospital Hahn/SGP  
APO, NY 09109-5000

USAF Clinic Sembac/USAFE  
APO New York 09130-5000

Commander  
10th Medical Laboratory  
ATTN: Audiologist  
APO New York 09180

USAF Hospital Torrejon/SGP  
APO New York 09285-5000

USAF Hospital Upper Heyford/SGP  
APO New York 09406-5000

USA Medical Liaison Officer  
US Embassy Box 54  
ATTN: USADO-AMLO  
FPO New York 09509

Air Force Office  
of Scientific Research  
European Office of Aerospace  
Research and Development (CI)  
Box 14  
FPO, NY 09510

USAF Clinic  
Bentwaters/SGPF  
APO, NY 09755-5000

Albert D. Anderson, M.D.  
930 Grand Concourse  
Bronx, NY 10451

U.S. Army Avionics Research  
and Development Activity  
ATTN: SAVAA-P-TP  
Fort Monmouth, NJ 07703-5401

USAF Clinic/SGP  
Box 3134  
APO New York 09057-5000

2 AES/SGNT  
APO New York 09057-5000

4684th ABG/SG  
APO New York 09121-5000

USAF Hospital Bitburg/SGP  
APO New York 09132-5000

USAF Hospital Iraklion/SG  
APO New York 09201-5000

USAF Clinic Aviano/SGPF  
APO New York 09293-5000

USAF Hospital Lajes/SGP  
APO New York 09406-5000

Biotechnology Liaison Officer  
DET 1, AFOSR (EOARD) Box 14  
FPO New York, NY 09510

Commanding Officer  
Office of Naval Research  
Branch Office  
Box 39  
FPO New York 0951-0700

Respiratory Therapy Services  
ATTN: SP/6 Fields  
Box 2  
APO, NY 09757

Director General Medical Services  
Naval Headquarters  
Sena Bhaven  
New Delhi, India 110011

Dr. Harold A. Lyons  
160 Harbor Road  
Sands Point, NY 11050

Dr. James D. Block  
Developmental Center  
Maimonides Community  
Mental Health Center  
4802 Tenth Avenue  
Brooklyn, NY 11218

Chief, Benet Weapons Laboratory  
LCWSL, USA ARRADCOM  
ATTN: DRDAR-LCB-TL  
Watervliet Arsenal, NY 12189

Commanding Officer  
Diving Medical Centre,  
MCM Service Marine Postkamer,  
Zuidwal 1, CA Den Helder  
The Netherlands 1780

Robert A. Montgomery  
Environmental Tectonics Corp.  
James Way  
County Line Industrial Park  
Southampton, PA 18966

Commander  
Man-Machine Integration System  
Code 602  
Naval Air Development Center  
Warminster, PA 18974

Commander  
Naval Air Development Center  
ATTN: Code 6021 (Mr. Brindle)  
Warminster, PA 18974

Mr. George Frisch  
Crew Systems (Code 99)  
Naval Air Development Center  
Warminster, PA 18974

Commander (60B)  
Naval Air Development Center  
Warminster, PA 18974-5000

William T. Ingram  
Department of Civil Engineering  
Polytechnic Institute of New York  
333 Jay Street  
Brooklyn, NY 11201

Dr. Murry Plissner  
303 Beverly Road  
Brooklyn, NY 11218

Sharon A. Mecca  
Scott Aviation Division  
of A-T-O Inc.  
225 Erie Street  
Lancaster, NY 14086

Commander (Code 8131)  
Naval Air Development Center  
Warminster, PA 18940

Commander  
Naval Air Development Center  
Biophysics Lab, ATTN: G. Kydd  
Code 60B1  
Warminster, PA 18974

Naval Air Development Center  
Technical Information Division  
Technical Support Detachment  
Warminster, PA 18974

Dr. E. Hendler  
Human Factors Applications, Inc.  
295 West Street Road  
Warminster, PA 18974

CPT William F. Maroney  
Code 60  
Naval Air Development Center  
Warminster, PA 18974

Dr. Alfred T. Kornfield  
3016 Reilere Dr.  
Drexel Hill, PA 19026

Leonard M. Pakman  
Department of Microbiology  
Temple University Dental School  
3223 North Broad Street  
Philadelphia, PA 19040

Michael P. Natt, Ph.D.  
Mgr. Scientific Information  
Wyeth Labs  
Box 8299  
Philadelphia, PA 19101

Boeing Vertol Company  
ATTN: M/S P32-18  
P.O. Box 16858  
Philadelphia, PA 19142

Dr. John B. Heyde  
The L.D. Caulk Co.  
P.O. Box 359  
Milford, DE 19963

Staff Office Aerospace Medicine  
RAF Staff, British Embassy  
3100 Massachusetts Avenue NW  
Washington, DC 20008

Medical Liaison Officer  
Canadian Defense Liaison Staff  
2450 Massachusetts Avenue NW  
Washington, DC 20008

Medical Liaison Officer  
Royal Air Force Staff  
British Embassy  
3100 Massachusetts Avenue NW  
Washington, DC 20008

Staff Office, Aerospace Medicine  
RAF Staff, British Embassy  
3100 Massachusetts Avenue NW  
Washington, DC 20008

American Psychological Association  
PSYCINFO Acquisitions  
and Selection Unit  
1200 Seventeenth Street NW  
Washington, DC 20036

Abraham Fremer  
Benson Manor, Suite 116B  
Jenkintown, PA 19046

George H. Stewart  
Temple University School of Medicine  
3400 North Broad Street  
Philadelphia, PA 19140

U.S. Air Force Hospital/SGP  
Dover Air Force Base 19901-5000

Assistant, Defense Research  
and Engineering  
Attache, Embassy of France  
4101 Reservoir Road, NW  
Washington, DC 20007

French Embassy  
Materiel, French Military Mission  
2164 Florida Avenue NW  
Washington, DC 20008

Royal Netherlands Embassy  
Office of Air Attache  
4200 Linnean Avenue NW  
Washington, DC 20008

Canadian Forces  
Medical Liaison Officer  
Canadian Defence Liaison Staff  
2450 Massachusetts Avenue NW  
Washington, DC 20008

Office of Air Attache  
Embassy of Australia  
1601 Massachusetts Avenue W  
Washington, DC 20036

Under Secretary of Defense  
for Acquisition  
Military Assistant  
for Medical Research  
The Pentagon, Room 30129  
Washington, DC 20301

OUSDRE (E&LS)  
The Pentagon, Room 3D129  
Washington, DC 20301

Under Secretary of Defense  
Research and Engineering  
Military Assistant,  
Training & Personnel Support  
The Pentagon  
Washington, DC 20301

John T. Legowik, M.D.  
Pulmonary Pathology  
Armed Forces  
Institute of Pathology  
Washington, DC 20306

Director  
Army Audiology and Speech Center  
Walter Reed Army Medical Center  
Washington, DC 20307-5001

Commander  
U.S. Army Institute  
of Dental Research  
Walter Reed Army Medical Center  
Washington, DC 20307-5300

Office of the Surgeon General  
Department of the Army  
Canadian Forces Medical  
Medical Liaison Office  
Washington, DC 20310

Headquarters  
U.S. Army, DAMA-WSA  
The Pentagon  
Washington, DC 20310

SAF/ALR (Dr. Bernard Paiewonsky)  
Deputy of Advanced Technology  
Assistant Secretary  
of the Air Force  
Research, Development and Logistics  
Room 4D-977, The Pentagon  
Washington, DC 20330-1000

HQ USAF/SGPA  
Bolling Air Force Base  
Washington, DC 20330-5000

Under Secretary of Defense  
for Research and Engineering  
ATTN: Military Assistant  
for Medical and Life Sciences  
Washington, DC 20301

Under Secretary of Defense  
for Acquisition  
Military Assistant  
for Medical Research  
The Pentagon, Room 3D129  
Washington, DC 20301

AFIP/CPL-A/COL Charles Ruehle  
Washington, DC 20306

COL Franklin H. Top, Jr., MD  
Walter Reed Army  
Institute of Research  
Washington, DC 20307-5100

DASG-AAFJML-P  
Joint Medical Library  
The Pentagon, Room 1B-473  
Washington, DC 20310

Headquarters  
Department of the Army  
(DASG-PSP-O)  
Washington, DC 20310

Deputy for Environment & Safety  
SAF/MIQ  
The Pentagon  
Washington, DC 20330

Director of Aerospace Sciences  
Bolling Air Force Base  
Washington, DC 20332

Air Force Office  
of Scientific Research/NL  
Bolling Air Force Base  
Washington, DC 20332-6448

HQAFSC/SGP  
Andrews Air Force Base,  
MD 20334-5000

AFSC/DL (Program Element Manager)  
Andrews Air Force Base, MD 20334

Chief of Naval Operations  
OP-91, Navy Department  
Washington, DC 20350-2000

Chief of Naval Operations  
OP-098, Navy Department  
Washington, DC 20350-2000

Naval Air Systems Command  
Code AIR-5311  
Washington, DC 20361

Commander  
Air Systems Command (AIR-931)  
Naval Air Systems Command HQ  
Washington, DC 20361-0001

Commander  
Naval Air Systems Command (AIR-933G)  
Naval Air Systems Command HQ  
Washington, DC 20361-9330

Commander  
Naval Medical Command (MED-23)  
Navy Department  
Washington, DC 20372-5120

Naval Research Laboratory Library  
Code 1433  
Washington, DC 20375

Commandant of the Marine Corps  
HQs, U.S. Marine Corps (MED)  
Washington, DC 20380-0001

Commander  
Air Force Systems Command  
Andrews Air Force Base  
Washington, DC 20334-5000

Assistant Secretary of the Navy  
Research, Engineering & Systems  
Navy Department  
Washington, DC 20350-1000

Chief of Naval Operations  
OP-50, Navy Department  
Washington, DC 20350-2000

Chief of Naval Operations  
OP-093, Navy Department  
Washington, DC 20350-2000

Naval Air Systems Command  
Technical Air Library 950D  
Jefferson Plaza II, Room 278  
Department of the Navy  
Washington, DC 20361

Commander  
Air Systems Command (AIR-531)  
Naval Air Systems Command HQ  
Washington, DC 20361-5310

Commander  
Naval Medical Command (MED-02D)  
Navy Department  
Washington, DC 20372-5120

Naval Medical Command  
(MEDCOM-00D4)  
Navy Departments  
Washington, DC 20372-5120

Naval Research Laboratory Library  
Shock and Vibration  
Information Center, Code 5804  
Washington, DC 20375

Commander of the Marine Corps  
HQs, U.S. Marine Corps (APW)  
Washington, DC 20380-0001

Surgeon General Malaysia  
USDAO Kuala Lumpur  
Department of State (Pouch Room)  
Washington, DC 20520

Jon L. Jorjan, M.D.  
Deputy Federal Air Surgeon AAM-2  
Federal Aviation Administration  
800 Independence Avenue SW  
Washington, DC 20591

Commander  
Naval Air Test Center (SY-70)  
Patuxent River, MD 20670-5304

Harry Diamond Laboratories  
Technical Information Branch  
2800 Powder Mill Road  
Adelphi, MD 20783-1197

Nicholas Yanowsky  
Code 49 Naval Medicine  
Research and Development Command  
Naval Medicine  
Command National Capital Region  
Bethesda, MD 20814

Commanding Officer (Code 404)  
Naval Medical Research  
and Development Command  
Bethesda, MD 20814-5044

Commanding Officer  
Naval Medical Research Institute  
Bethesda, MD 20814-5055

Arthur A. Wykes, Ph.D.  
Toxicology Information Program  
NLM, NIH, DHEW  
18900 Diary Road  
Gaithersburg, MD 20879

U.S. Army Materiel Systems  
Analysis Agency  
ATTN: Reports Processing  
Aberdeen Proving Ground,  
MD 21005-5017

NASA Headquarters  
NHB-12  
600 Independence Avenue, SW  
Washington, DC 20546

U.S. Navy Liaison Officer  
Federal Aviation Administration  
800 Independence Avenue SW  
Washington, DC 20591

Dr. Charles J. Ruehle  
1000 Lower Pindell Road  
Lothian, MD 20711

AFRRI Library  
NNMC Building 42  
Bethesda, MD 20814

National Library of Science  
TS-Index Medicus  
8600 Rockville Pike  
Bethesda, MD 20814

Commanding Officer  
Naval Medical Research  
and Development Command  
NMC NCR  
Bethesda, MD 20814-5044

Commanding Officer  
Naval Medical Research  
and Development Command  
National Naval Medical Center  
Bethesda, MD 20817

Director  
U.S. Army Human Engineering  
Laboratory Technical Library  
Aberdeen Proving Ground,  
MD 21005-5001

Commander  
U.S. Army Test and Evaluation  
Command ATTN: AMSTE-AD-H  
Aberdeen Proving Ground,  
MD 21005-5055

Director  
U.S. Army Ballistic  
Research Laboratory  
ATTN: DRXBR-OD-Tech Reports  
Aberdeen Proving Ground,  
MD 21005-5066

U.S. Army Environmental Hygiene  
Agency Laboratory  
Building E-2100  
Aberdeen Proving Ground,  
MD 21010

Technical Library  
Chemical Research  
and Development Center  
Aberdeen Proving Ground,  
MD 21010

Commander  
U.S. Army Medical Research  
and Development Command  
ATT: SGRD-RMS (Mrs. Madigan)  
Fort Detrick, Frederick,  
MD 21701

Commander  
U.S. Army Medical Bioengineering  
Research and Development Lab  
ATTN: SGRD-UBZ-I  
Fort Detrick, Frederick, MD 21701

Office of Naval Research  
Code 440  
800 North Quincy Street  
Arlington, VA 22217

Director, Biological  
Sciences Division  
Office of Naval Research  
600 North Quincy Street  
Arlington, VA 22217

DTIC/FDAC  
Cameron Station  
Alexandria, VA 22304-6145

Commander  
U.S. Army Materiel Command  
ATTN: AMCDE-S (CPT Broadwater)  
5001 Eisenhower Avenue  
Alexandria, VA 22333

U.S. Army Ordnance Center  
and School Library  
Building 3071  
Aberdeen Proving Ground,  
MD 21005-5201

Commanding Officer  
USAEHA  
ATTN: Library Building E-2100  
Aberdeen Proving Ground,  
MD 21010-5000

Commander  
U.S. Army Medical Research  
Institute of Chemical Defense  
ATTN: SGRD-UV-AO  
Aberdeen Proving Ground,  
MD 21010-5425

Commander  
U.S. Army Medical Research  
Institute of Infectious Diseases  
Fort Detrick, Frederick, MD 21701

Commanding General  
Marine Corps Development  
and Education Command  
Quantico, VA 22134-5001

Office of Naval Research  
Code 441  
800 North Quincy Street  
Arlington, VA 22217

Chief of Naval Research  
ONR-144  
800 North Quincy Street  
Arlington, VA 22217-5000

Defense Techn Information Center  
Cameron Station  
Alexandria, VA 22314

Commanding Officer  
U.S. Army Research Institute  
5001 Eisenhower Avenue  
Alexandria, VA 22333



HQ, Department of the Army  
Office of The Surgeon General  
British Medical Liaison Officer  
DASG-ZX/COL M. Daly  
5109 Leesburg Pike  
Falls Church, VA 22401-3258

Mr. James S. Herndon  
Center for Applied  
Psychological Studies  
Old Dominion University  
Norfolk, VA 23508-8561

Commander  
Naval Air Force  
U.S. Atlantic Fleet (Code 018)  
Norfolk, VA 23511-5188

Commandant  
U.S. Army Aviation  
Logistics School  
ATTN: ATSQ-TDN  
Fort Eustis, VA 23604

U.S. Army Training  
and Doctrine Command  
ATTN: ATCD-ZX  
Fort Monroe, VA 23651

Structures Laboratory Library  
USARTL-AVSCOM  
NASA Langley Research Center  
Mail Stop 266  
Hampton, VA 23665

William J. Murray, M.D.  
Box 3094  
Department of Anesthesiology  
Duke University Medical Center  
Durham, NC 27710

Commanding Officer  
Headquarters, RAAF Base  
Point Cook Victoria,  
Australia 3029

Aeromedical Service  
U.S. Air Force Hospital/SGP  
Moody Air Force Base, GA 31699

U.S. Army Foreign Science  
and Technology Center  
ATTN: MTZ  
220 Seventh Street NE  
Charlottesville, VA 22901-5396

Mr. Ben B. Morgan, Jr.  
Center for Applied  
Psychological Studies  
Old Dominion University  
Norfolk, VA 23508-8561

Commanding General  
Fleet Marine Force, Atlantic  
Norfolk, VA 23515

Director,  
Applied Technology Laboratory  
USARTL-AVSCOM  
ATTN: Library, Building 401  
Fort Eustis, VA 23604

U.S. Army Training  
and Doctrine Command  
ATTN: Surgeon  
Fort Monroe, VA 23651-5000

HQTAC (SGPA)  
Langley AFB, VA 23665-5000

Aviation Medicine Clinic  
TMC #22, SAAF  
Fort Bragg, NC 28305

John R. Barry  
Psychology Department  
University of Georgia  
Athens, GA 30602

Aerospace Physiology  
U.S. Air Force Hospital Tyndall  
Tyndall Air Force Base,  
FL 32403-5000

Naval Aerospace Medical  
Institute Library  
Building 1953, Code 102  
Pensacola, FLA 32508

Chief of Naval Education  
and Training N-02  
NAS Pensacola, FL 32508

Commanding Officer  
Naval Aerospace Medical Institute  
Building 488  
NAS Pensacola, FL 32508-5600

Commanding Officer  
Naval Training Systems Center  
Orlando, FL 32813

U.S. Air Force Hospital/SGT  
Patrick Air Force Base,  
FL 32935-5000

Command Surgeon  
U.S. Central Command  
MacDill Air Force Base, FL 33608

Dr. Richard B. Shepard  
Department of Surgery/UAB  
718 Lyons Harrison Research Bldg.  
Birmingham, AL 35294

Air University Library  
(AUL/LSE)  
Maxwell Air Force Base, AL 36112

Commander  
U.S. Army Aviation Center  
and Fort Rucker  
ATTN: ATZQ-CDR  
Fort Rucker, AL 36362

Directorate of Training Development  
Building 502  
Fort Rucker, AL 36362

Chief  
Human Engineering Laboratory  
Field Unit  
Fort Rucker, AL 36362

Chief of Naval Education  
and Training  
N-1  
NAS Pensacola, FL 32508-5100

Chief of Naval Education  
and Training N-5  
NAS Pensacola, FL 32508

U.S. Air Force Armament  
Development and Test Center  
Eglin Air Force Base, FL 32542

Commanding Officer  
Naval Training Equipment Center  
Orlando, FL 32813-7100

CDR Stanley J. Coltune  
1655Drexel Avenue  
Miami Beach, FL 33139

U.S. Air Force Regional  
Regional Hospital/SGP  
MacDill Air Force Base, FL 33608

U.S. Army Missile Command  
Redstone Scientific Information  
Center ATTN: Documents Section  
Redstone Arsenal, AL 35898-5241

Commander  
U.S. Army Aeromedical Center  
Fort Rucker, AL 36362

Directorate of Combat Developments  
Building 507  
Fort Rucker, AL 36362

Chief  
Army Research Institute Field Unit  
Fort Rucker, AL 36362

Commander  
U.S. Army Safety Center  
Fort Rucker, AL 36362

Commander  
U.S. Army Aviation Center  
and Fort Rucker  
ATTN: ATZQ-T-ATL  
Fort Rucker, AL 36362

President  
U.S. Army Aviation Board  
Cairns Army Air Field  
Fort Rucker, AL 36362

Netherlands Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

British Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

Director  
U.S. Army Aeromedical Activity  
ATTN: HSXY-A  
Fort Rucker, AL 36362-5000

CPT Dennis R. Trotts  
U.S. Air Force Hospital/SGT  
Columbus, MS 39701-5000

Dr. C.A. Mertz  
2101 East 41st Street  
Ashtabula, OH 44004

National Occupational Safety  
and Health Library C-21  
Robert A. Taft Labs  
4676 Columbia Parkway  
Cincinnati, OH 45226

AFAMRL/HEX  
Wright-Patterson AFB, OH 45433

Mr. Mark W. Cannon, Jr.  
Human Engineering Division/HEA  
U.S. Air Force Aerospace  
Medical Research Laboratory  
Wright-Patterson AFB, OH 45433

U.S. Army Aircraft Development  
Test Activity  
ATTN: STEBG-MP-QA  
Cairns Army Air Field  
Fort Rucker, AL 36362

Canadian Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

German Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

French Army Liaison Office  
Building 602  
Fort Rucker, AL 36362

Chief of Naval Technical  
Trainin (Code 0160)  
NAS Memphis  
Millington, TN 38054

Flight Surgeon's Office  
U.S. Air Force Hospital/SGP  
Columbus Air Force Base, MS 39701

U.S. Army Research & Technology  
Laboratories (AVSCOM)  
Propulsion Laboratory MS 302-2  
NASA Lewis Research Center  
Cleveland, OH 44135

Wright State University  
School of Medicine  
Dept. of Community Medicine  
P.O. Box 927  
Dayton, OH 45401

U.S. Air Force Institute  
of Technology (AFIT/LDEE)  
Building 640, Area B  
Wright-Patterson AFB, OH 45433

Naval Medical Research Institute  
Toxicology Detachment (NMRI/TD)  
Building 433, Area B  
Wright Patterson AFB, OH 45433

Naval Medical Research Institute  
Toxicology Detachment (NMRI/TD)  
Building 433, Area B  
Wright-Patterson AFB, OH 45433

AAMRL/TIS(STINFO)  
Wright-Patterson AFB, OH 45433

Mr. Herbert A. Colle  
Department of Psychology  
Wright State University  
Dayton, OH 45435

Dr. William G. Shafer  
Indiana University  
School of Dentistry  
1121 West Michigan Street  
Indianapolis, IN 46202

University of Michigan  
NASA Center of Excellence  
in Man-Systems Research  
ATTN: R.G. Snyder, Director  
Ann Arbor, MI 48109

Waldo F. Keller, D.V.M.  
A153 Veterinary Clinical Center  
College of Veterinary Medicine  
Michigan State University  
East Lansing, MI 48824

Government Publications Department  
University of Iowa Library  
Iowa City, IA 52242

133 TAC Hospital  
Minnesota Air National Guard  
Minneapolis-St Paul, MN 55111

U.S. Air Force  
Regional Hospital/SGAS  
Minot Air Force Base, ND 58701

U.S. Air Force AMRL/VL  
Building 838  
Wright-Patterson AFB, OH 45433

Commanding Officer  
Harry G. Armstrong Aerospace  
Medical Research Laboratory  
Wright-Patterson AFB, OH 45433

Wright State University  
Biomedical Engineering Dept.  
ATTN: Dr. A. J. Caciappo  
School of Engineering  
Dayton, OH 45435

191 U.S. Air Force Clinic  
Selfridge Air Guard Base,  
MI 48045

Dr. James K. Avery  
The University of Michigan  
School of Dentistry  
Room #3209  
Ann Arbor, MI 48109

Roger DeHaan  
921 Britten Avenue  
Lansing, MI 48910-1325

Technical Report Center  
Engineering Library  
215 North Randall Avenue  
Madison, WI 53706

LT COL Letter G.H. Lewis  
HC 70 Box 4705 Lake Kabekona  
Laporte, MN 56461-9502

Dr. M. K. Wells  
Department of Civil Engineers  
and Engineering Mechanics  
Montana State University  
Bozeman, MT 59170

Commanding Officer  
Naval Dental Research Institute  
Great Lakes, IL 60088-5259

John J. Hefferren, Ph.D.  
American Dental Association  
211 East Chicago Avenue  
Chicago, IL 60950

Henry L. Taylor  
Director, Institute of Aviation  
  
University of Illinois-  
Willard Airport  
Savoy, IL 61874

HQ MAC/SGPB  
Scott Air Force Base, IL 62225

Derlene R. Sredl  
AV-Nurse International Inc.  
P.O. Box 1247  
Ballwin, MS 63011

Commander  
U.S. Army Aviation Systems Command  
ATTN: DRSAB-ED  
4300 Goodfellow Boulevard  
St. Louis, MO 63120

Commander (ATTN: AMSAB-DACL)  
U.S. Army Aviation Systems Command  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798

Project Officer  
Aviation Life Support Equipment  
ATTN: AMCPO-ALSE  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798

Dr. Benjamin D. Fremming  
Laboratory Animal Center  
1015 East 50th Street  
Kansas City, MO 64110

Laura Ann Wilber, Ph.D.  
Hearing Clinic  
Frances Searle Building  
Northwestern University  
2299 Sheridan  
Evanston, IL 60201

U.S. Air Force Hospital/ATC  
Chanute Air Force Base,  
IL 61868

John A. Dellinger, MS, ATP  
University of Illinois-  
Willard Airport  
Savoy, IL 61874

HQ MAC/SGPC  
Scott Air Force Base, IL 62225

Commander  
U.S. Army Aviation Systems Command  
ATTN: SGRD-UAX-AL (MAJ Lacy)  
4300 Goodfellow Blvd., Bldg. 105  
St. Louis, MO 63120

U.S. Army Aviation Systems Command  
Library & Information Center Br.  
ATTN: DRSAB-DIL  
4300 Goodfellow Boulevard  
St. Louis, MO 63120

Commander  
U.S. Army Aviation Systems Command  
ATTN: DRSAB-WS  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798

George X. Trimble, M.D.  
101 Memorial Drive  
Kansas City, MO 64108

Dr. Jay Goldman  
113 Electrical Engineering  
University of Missouri  
Columbia, MO 65211

Document Department  
Library  
Kansas State University  
Manhattan, KS 66506

HQSAC/SGPF  
Offutt Air Force Base, NE 68113

Dr. James May  
Department of Psychology  
University of New Orleans, Lakefront  
New Orleans, LA 70148

Medical Library  
USAF Hospital England/SGOAL  
England AFB, LA 71322

Dr. Jerry L. Purswell  
202 West Boyd, # 124  
University of Oklahoma  
Norman, OK 73069

Federal Aviation Administration  
Civil Aeromedical Institute, AAM-100  
P.O. Box 25082  
Oklahoma City, OK 73125

Federal Aviation Administration  
Civil Aeromedical Institute  
CAMI Library AAC 64D1  
P.O. Box 25082  
Oklahoma City, OK 73125

Mr. Thompson  
OC-ALC/MMIRAE  
Tinker Air Force Base, OK 73145

Mr. Ron Griffin  
OC-ALC/MMIRAP  
Tinker Air Force Base, OK 73145

U.S. Air Force Hospital Tinker/SGPS  
Tinker Air Force Base, OK 73145

Boeing Military Airplane Co.  
Library  
Wichita, KS 67210

Chairman  
Department of Psychology  
Tulane University  
New Orleans, LA 70018

Commanding Officer  
Naval Biodynamics Laboratory  
P.O. Box 29407  
New Orleans, LA 70189-0407

Harry D. Olree  
P.O. Box 765  
Hading College  
Searcy, AR 72143

J.R. Hordinsky, M.D.  
Mgr., Aeromedical Research Br.  
AAC-110 FAA  
P.O. Box 25032  
Oklahoma, OK 73125

Dr. William E. Collins  
FAA-CAM1, AAC-118  
P.O. Box 25082  
Oklahoma City, OK 73125

J. Robert Dille, M.D., AC-100  
Dir., Civil Aeromedical Institute  
Federal Aviation Administration  
P.O. Box 25082  
Oklahoma City, OK 73125

Mr. Robert Oltmanns  
OC-ALC/MMIRAE  
Tinker Air Force Base, OK 73145

Charles J. Hoskins  
OC-ALC/MMIRAP  
Tinker Air Force Base, OK 73145

U.S. Army Field Artillery School  
ATTN: Library  
Snow Hall, Room 14  
Fort Sill, OK 73503

Ministere de la Defense  
EASSAA-CERMA  
26, boulevard Victor  
Paris Armees, France 75996

S.B. Sells, Ph.D.  
Director Institute  
of Behavioral Research  
Texas Christian University  
Box 32902  
Fort Worth, TX 76129

Houston Academy of Medicine  
Texas Medicine Center Library  
Jesse H. Jones Library Building  
Houston, TX 77030

William J. Frome, D.D.S.  
NASA/Johnson Space Center SD24  
Houston, TX 77058

Chairman  
Department of Psychology  
Texas A&M University  
College Station, TX 77843

Herman S. Wigodsky  
420 East Houston Street  
San Antonio, TX 78205

Dr. Bryce O. Hartman  
USAFSAM/NG  
Brooks Air Force Base, TX 78234

Commander  
U.S. Army Institute  
of Surgical Research  
ATTN: SGRD-USM (Jan Duke)  
Fort Sam Houston, TX 78234-6200

U.S. Air Force School  
of Aerospace Medicine  
Strughold Aeromedical Library  
Documents Section, USAFSAM/TSK-4  
Brooks Air Force Base, TX 78235

Ecole D'Application Du Service  
De Sante, Pour L'Armee De L'Air  
Et Centre D'Estudes  
De Medecine Aerospatiale  
26, boulevard Victor  
Paris Armees, France 75996

Texas Christian University  
Box 32902  
Fort Worth, TX 76129

Richard T. Walter EN-3  
NASA Johnson Space Center  
Houston, TX 77058

NASA  
Mail Code CB/Senior Naval Officer  
Johnson Space Center  
Houston, TX 77058

HQATC/SGPA  
Randolph Air Force Base, TX 78150

Commander  
U.S. Army Academy  
of Health Sciences  
ATTN: Library  
Fort Sam Houston, TX 78234

Commander  
U.S. Army Health Services Command  
ATTN: HSOP-SO  
Fort Sam Houston, TX 78234-6000

Director of Professional Services  
AFMSC/GSP  
Brooks Air Force Base, TX 78235

USAFSAM/EDB  
ATTN: T.A.C.O  
Brooks Air Force Base, TX 78235

USAFSAM/EDB  
ATTN: MAJ Rick Island  
Brooks Air Force Base, TX 78235

HSD/SORT  
ATTN: Belva Williams  
Brooks Air Force Base, TX 78235

Dr. Samuel G. Schiflett  
USAFSAM/VNB  
Brooks Air Force Base, TX 78235

Commander  
U.S. Air Force  
Human Systems Division  
Brooks Air Force Base, TX 78235

Stronghold Aeromedical Library  
Documents Section (TSKD)  
U.S. Air Force  
School of Aerospace Medicine  
Brooks Air Force Base, TX 78235

MSgt Loras White  
433rd TAC Hospital  
433 TAW  
Kelly Air Force Base, TX 78241

Chief of Naval Air Training  
N-3  
NAS Corpus Christi, TX 78419

U.S. Air Force Hospital Laughlin/SGP  
Laughlin Air Force Base, TX 78840

Dr. Charles Wilber  
Department of Zoology  
Colorado State University  
Fort Collins, CO 80523-5000

U.S. Army Dugway Proving Ground  
Technical Library  
Building 5330  
Dugway, UT 84022

U.S. Army Yuma Proving Ground  
Technical Library  
Yuma, AZ 85364

U.S. Air Force Clinic/SGP  
Brooks Air Force Base, TX 78235

USAFSAM/TSK  
Brooks Air Force Base, TX 78235

USAFSAM/NGEA  
ATTN: Mr. Sutherland  
Brooks Air Force Base, TX 78235

HSD/SORT/Mrs. L. Glisson  
Brooks Air Force Base, TX 78235

Aerospace Associates Inc.  
309 Driftwind  
San Antonio, TX 78239

Head, Aviation Physiology Training  
Naval Regional Medical Center  
Code 08  
Corpus Christi, TX 78419

Memorial Library  
1801 Lamar Boulevard  
Austin, TX 78701

Chairman  
Psychology Department  
Texas Tech University  
Lubbock, TX 79409

USAF Clinic/SG  
Peterson Field, CO 80914-5000

Arizona State University Library  
Government Documents  
Tempe, AZ 85281

U.S. Air Force Hospital  
Davis Monthan Air Force Base  
AZ 85707-5000



162 Tactical Clinic (TAC) AzANG  
P.O. Box 11037  
Tucson, AZ 85734

U.S. Air Force  
Hospital Kirland/SGAL  
Kirtland Air Force Base, NM 87115

U.S. Air Force Hospital/SGHL  
Holloman Air Force Base, NM 88330

Biomedical Library  
Center for Health Sciences  
University of California  
Los Angeles, CA 90024

Library  
Los Angeles County  
Medical Association  
634 South Westlake Avenue  
Los Angeles, CA 90057

USAF Clinic Chicksand/SGA  
APO New York 90103-5000

146 TAC Hospital (MAC)  
8030 Balboa Boulevard  
Van Nuys, CA 91409

Library  
Naval Health Research Center  
P.O. Box 85122  
San Diego, CA 92138-9174

NPRDC Technical Library  
San Diego, CA 92152

Mr. Howard A. Hasbrook  
Aviation Safety Consultant  
Campwood Route  
Prescott, AZ 86301

U.S. Army White Sands  
Missile Range  
Technical Library Division  
White Sands Missile Range,  
NM 88002

Joseph Raymond, M.D.  
Associate Director  
UCLA Center for Health Science  
Los Angeles, CA 90024

Oscar J. Balchum, M.D.  
University of Southern California  
Medical School  
2025 Zonal Avenue  
Los Angeles, CA 90033

Dr. Diane Damos  
Department of Human Factors  
ISSM, USC  
Los Angeles, CA 90089-0021

Medecin-Chef du Centre d'Essais  
en Vol (CEV) et du Laboratoire  
de Medecine Aerospatiale (LAMAS)  
Centre d'Essais en Vol, B.P. No 2  
Bretigny Air, France 91220

Commander  
Naval Air Force  
U.S. Pacific Fleet (Code 014)  
NAS North Island  
San Diego, CA 92135-5100

Commanding Officer  
Naval Health Research Center  
P.O. Box 85122  
San Diego, CA 92138-9174

Commanding Officer  
Library Code 231  
Navy Personnel Research  
and Development Command  
San Diego, CA 92152-6800

U.S. Air Force  
Clinic Norton/SGP  
Norton Air Force Base, CA 92409

AFFTC Technical Library  
6520 TESTG/ENXL  
Edwards Air Force Base, CA 93523

Mr. Ron Erikson  
Code 31504  
Naval Weapons Center  
China Lake, CA 93555

Commander (Code 64A)  
Naval Weapons Center  
China Lake, CA 93555

Charles E. Billings  
Mail Stop 239-2  
NASA-AMES Research Center  
Moffett Field, CA 94035

Dr. Alan Chambers  
Mail Stop 239-1  
Ames Research Center  
Moffett Field, CA 94035

Commander  
Letterman Army Institute of Research  
ATTN: Medical Research Library  
Presidio of San Francisco,  
CA 94129

David Grant Medical Center/SGPM  
Travis Air Force Base, CA 94535

Bruce W. Jackson, M.D.  
2828 Russell Streer  
Berkeley, CA 94705

Dr. A. H. Smith  
Chronic Acceleration Research  
Dept. of Animal Physiology  
University of California  
Davis, CA 95616

Commander  
Pacific Missile Test Center  
Point Mugu, CA 93042

U.S. Army Aviation Engineering  
Flight Activity  
ATTN: SAVTE-M (Tech Lib) Stop 217  
Edwards Air Force Base, CA 93523

Commander  
Code 3431  
Naval Weapons Center  
China Lake, CA 93555

U.S. Army Combat Developments  
Experimental Center  
Technical Information Center  
Building 2925  
Fort Ord, CA 93941-5000

NASA  
Ames Research Center  
Library 202-3  
Moffett Field, CA 94035

Aeromechanics Laboratory  
U.S. Army Research  
and Technical Laboratories  
Ames Research Center, M/S 215-1  
Moffett Field, CA 94035

Sixth U.S. Army  
ATTN: SMA  
Presidio of San Francisco,  
CA 94129

Director  
Naval Biosciences Laboratory  
Naval Supply Center, Bldg 844  
Oakland, CA 94625

U.S. Air Force  
Hospital Castle/SGP  
Castle Air Force Base, CA 95342

U.S. Air Force  
Clinic McClellan/SGP  
McClellan Air Force Base,  
CA 95652-5000

U.S. Air Force Hospital Mather/SGP  
Mather Air Force Base, CA 95655

USAF Hospital Yokota/SGPF  
APO San Francisco, CA 96328

Surgeon General Thailand  
USDAO American Embassy  
APO San Francisco 96336-5000

USAF Hospital OSAN/SGP  
APO San Francisco 96570-5000

HQ PACAF/SGPA  
Hickam Air Force Base, HI 96853

The Boeing Military Airplane Co.  
ATTN: Library Acquisitions  
P.O. Box 3707  
Seattle, WA 98124

Engineering Library  
University of Washington  
Seattle, WA 98195

Commanding Officer  
Centre of Aerospace Medicine  
Quarter's King Albert Ith  
Raketstraat 70  
Brussels, Belgium B-1130

Schiffahrtmedizinisches Institut  
der Marine  
Bibliotheksoffizier  
Kopperpähler Allee 120  
Kronshagen  
Federal Republic of Germany D-2300

Director Naval Medical Service  
Chief of Defence  
Postbox 202  
Vedbaek, Denmark DK 2950

MAJ Tim Philpott  
USAF Clinic/15PTF  
APO San Francisco, CA 96239

Medical Library  
USAF Clinic Andersen  
SAC/SGPB  
APO San Francisco 96334-5000

Commanding Officer  
U.S. Naval Medical Research  
Unit No. 2  
APO San Francisco 96528-5000

Surgeon Major, Singapore AF  
USDA, American Embassy  
APO San Francisco 96699-0001

Commanding General  
Fleet Marine Force, Pacific  
Camp H. M. Smith, HI 96861

Primate Information Center  
Regional Primate Research Ctr.  
University of Washington  
Seattle, WA 98195

U.S. Air Force  
Clinic McChord/SGP  
McChord Air Force Base, WA 98438

Commanding Officer  
404 Squadron CFB Greenwood  
Greenwood, NS, Canada B0P 1N0

Head, Underwater Medicine Division  
DFVLR Institute for Aerospace  
Medicine  
Linder Höhe, Köln 90  
Federal Republic of Germany D-5000

DRIC, Distribution Section  
Procurement Executive  
Ministry of Defence  
Kentigern House, 65 Brown Street  
Glasgow, United Kingdom G2 8EX

National Defence Headquarters  
101 Colonel By Drive  
ATTN: DPM  
Ottawa, Ontario, Canada K1A 0K2

USAF/AFSC Liaison Office  
110 O'Connor Street, Suite #202  
Ottawa, Ontario, Canada K1P5J6

Major J. Soutendan (Retired)  
Technical Advisor, Canadian  
Air Line Pilots Association  
1300 Steeles Avenue East  
Brampton, Ontario, Canada L6T 1A2

Chief  
Defence and Civil Institute  
of Environmental Medicine  
P.O. Box 2000  
ATTN: Director MLSD  
Downsview, Canada M3M 3B9

Aeromedical Training Officer  
School of Operational  
and Aviation Medicine  
Defense & Civil Institute of Envir.  
Medicine, 1133 Sheppard Avenue West  
Downsview, Ontario, Canada M3M 3B9

Dr. Alan H. Roscoe  
Medical Department  
Royal Aircraft Establishment  
Bedford, United Kingdom MK41 GAE

Head, DRPS  
Institute of Naval Medicine  
Alverstoke Gosport Hants  
United Kingdom PO12 2DL

FOA Dept. 5  
Linköping, Sweden S-580 13

Dept. of Aviation Medicine  
HQ Director Army Air Corps  
Middle Wallop, Stockbridge  
Hants, United Kingdom SO20 8DY

Dr. S. Laham, Head  
Occupational Toxicology Research  
B-35, Environmental Health Centre  
Health and Welfare  
Ottawa, Canada K1A 0L2

Health Science Library  
University of Alberta  
Edmonton, Alberta, Canada T6G 2J8

Professor G. R. Hervey  
Department of Physiology  
The University of Leeds  
Leeds, United Kingdom LS2 9JT

Officer Commanding  
School of Operational  
and Aerospace Medicine  
DCIEM P.O. Box 2000  
1133 Sheppard Avenue West  
Downsview, Canada M3M 3B9

Canadian Society of Aviation  
Medicine c/o Academy of Medicine  
ATTN: Ms. Carmen King  
288 Bloor Street West  
Toronto, Canada M5S 1V8

University of Trondheim  
Norwegian Institute of Technology  
The Library  
Trondheim-NTH, Norway N-7034

Head, DRPS  
Institute of Naval Medicine  
Alverstoke Gosport Hants  
United Kingdom PO12 2DL

Specialist in Aviation Medicine  
HQ, Director A&M MR Corps  
Middle Wallop, Stockbridge  
Hants, United Kingdom SO20 8DY

Specialist in Aviation Med.  
HQ Director A&M MR Corps  
Middle Wallop, Stockbridge  
Hants, United Kingdom SO20 8DY

Department of Aviation Medicine  
HQ Director Army Air Corps  
Middle Wallop, Stockbridge  
Hants, United Kingdom S020 8DY